State of Utah

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Department of
Environmental Quality

Amanda Smith
Executive Director

DIVISION OF RADIATION CONTROL
Rusty Lundberg
Director

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February 13, 2013

DRC-2013-001269

Harold Roberts
Executive Vice President and Chief Operating Officer
Energy Fuels Resources (USA) Inc.
225 Union Blvd., Suite 600
Lakewood, CO 80228

RE: Review of August 15, 2012 (and May 31, 2012) Energy Fuels Resources (USA) Inc. Responses to Round 1 Interrogatories on Revision 5 Reclamation Plan Review, White Mesa Mill Site, Blanding, Utah, report dated September 2011

Dear Mr. Roberts:

Enclosed is URS Professional Solutions' review of Energy Fuels Resources responses to the Round I Interrogatories on Revision 5 Reclamation Plan. The enclosed table (Table 1) and attached Technical Memorandum (Attachment A – Revision 5 Reclamation Plan Round 1 [Rd 1] Interrogatories, Responses, and Discussion) document the results of URS Professional Solutions' (Professional Solutions') review, conducted on behalf of the Utah Division of Radiation Control (the Division), of Energy Fuels Resources (USA) Inc.'s (EFR's) Responses to Round 1 (Rd 1) Interrogatories submitted by the on Revision 5 Reclamation Plan dated September 2011 prepared by Denison Mines (USA) Corp. (now EFR).

Table 1 presented below states additional analyses and information required, in Professional Solutions' opinion, to enable the Division to thoroughly evaluate EFR's Revision 5 Reclamation Plan report and responses to the Round 1 Interrogatories previously submitted on that report. Additional information requested from EFR is summarized in the third column of the table. The table summarizes remaining technical issues related to the Revision 5 Reclamation Plan (and associated appendices and other supporting documents), identifies additional actions, analyses, and/or revisions that are requested from EFR in conjunction with the review of the Revision 5 Reclamation Plan in order to allow these identified issues to be adequately evaluated and resolved.

Attachment A restates the Rd 1 interrogatories the Division transmitted to EFR on the Revision 5 Reclamation Plan, repeats EFR's responses to those interrogatories, and provides discussion summarizing the results of the review of each response. The Rd 1 Interrogatories and EFR's Responses to those interrogatories are summarized in the same order in which the

Rd 1 Interrogatories were originally submitted.

If you have any questions regarding this letter or the enclosure, please feel free to contact me at 801-536-4263.

Sincerely,

John Hultquist, Section Manager
LLRW/Uranium Mill Licensing Section

JH:jh

Cc: Jo Ann Tischler, Director, Compliance and Permitting

URS

Technical Memorandum

Date:	February13, 2013 UT11.1102.004 OUT
To:	**John Hultquist, Utah Division of Radiation Control**
From:	Jon Luellen, URS Professional Solutions Robert Baird, URS Professional Solutions
Subject:	**Review of August 15, 2012 (and May 31, 2012) Energy Fuels Resources (USA) Inc. Responses to Round 1 Interrogatories on Revision 5 Reclamation Plan Review, White Mesa Mill Site, Blanding, Utah, report dated September 2011**

The enclosed table (Table 1) and attached Technical Memorandum (Attachment A – Revision 5 Reclamation Plan Round 1 [Rd 1] Interrogatories, Responses, and Discussion) document the results of URS Professional Solutions' (Professional Solutions') review, conducted on behalf of the Utah Division of Radiation Control (the Division), of Energy Fuels Resources (USA) Inc.'s (EFR's) Responses to Round 1 (Rd 1) Interrogatories submitted by the on Revision 5 Reclamation Plan dated September 2011 prepared by Denison Mines (USA) Corp. (now EFR).

Table 1 presented below is intended to succinctly state additional analyses and information required, in Professional Solutions' opinion, to enable the Division to thoroughly evaluate EFR's Revision 5 Reclamation Plan report and responses to the Round 1 Interrogatories previously submitted on that report. Salient additional information requested from EFR is summarized in the third column of the table. The table summarizes remaining technical issues related to the Revision 5 Reclamation Plan (and associated appendices and other supporting documents), identifies additional actions, analyses, and/or revisions that are requested from EFR in conjunction with the review of the Revision 5 Reclamation Plan in order to allow these identified issues to be adequately evaluated and resolved.

Attachment A restates the Rd 1 interrogatories the Division transmitted to EFR on the Revision 5 Reclamation Plan, repeats EFR's responses to those interrogatories, and provides discussion summarizing the results of the review of each response. The Rd 1 Interrogatories and EFR's Responses to those interrogatories are summarized in the same order in which the Rd 1 Interrogatories were originally submitted.

URS Corporation
756 E Winchester Street, Suite 400
Salt Lake City, UT 84107
Tel. 801 904 4000
Fax 801 904 4100
www urscorp com

TECHNICAL MEMORANDUM

WHITE MESA MILLSITE – REV 5.0 RECLAMATION PLAN REVIEW

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ISSUE(S)	APPLICABLE REPORT SECTION(S) &/or INTERROGATORY RESPONSE ITEM(S)	REQUIRED ADDITIONAL PLANS, ANALYSES, &/or REVISION(S)	APPLICABLE REGULATORY CRITERIA AND GUIDELINES
COVER SYSTEM CONSTRUCTION/ CONSTRUCTABILITY			
Cover Constructability – Insufficient information has been provided to justify/demonstrate that the proposed ET cover can be constructed in a reliable fashion to achieve the extremely flat proposed topslope inclinations in a continuous and uniform manner across the entire topslope cover footprint area	• EFR Response to Round 1 Interrogatory 3/1 on Rev 5.0 Rec Plan (5/31/12 and 8/15/12) • Section 5 of Attachment B, Construction Quality Assurance/Quality Control Plan, to the Reclamation Plan, Rev. 5.0	(See Section 3.0 the Technical Memorandum for details) Provide additional data, analyses, and information that satisfactorily justify/support the contention that the currently proposed cover system having such extremely flat topslope inclinations can be constructed uniformly and reliably over the entirety of the currently proposed topslope area This issue needs to be addressed before appropriate conclusions can be reached concerning the constructability of the cover as currently proposed	UAC R313-24-4; 10 CFR 40 Appendix A, Criterion 1 and 4
CQA/QCQ Plan – CQA/CQC Measures/Methods to Employed During Cover Construction – Additional information needs to be provided regarding the means and procedures that would be implemented as part of the CQA/CQC activities for controlling, verifying, and documenting layer thicknesses and final grades achieved for layers in the cover constructed across the top portions of the cover system	• EFR Response to Round 1 Interrogatory 3/1 on Rev 5 0 Rec Plan (05/31/12 and 08/15/12) • Section 5 of Attachment B, Construction Quality Assurance/Quality Control Plan, to the Reclamation Plan, Rev 5.0	(See Section 3.0 the Technical Memorandum for details) Additional information needs to be provided in Attachment A (Technical Specifications, Section 8) and Attachment B (CQA/CQC Plan, Section 6) to the Rev 5 0 Reclamation Plan or in EFR's response regarding the means and procedures that would be implemented for controlling, verifying, and documenting layer thicknesses and final grades of layers constructed in the cover across the top portions of the cover system. Provide additional information regarding the need for use of Global Positioning System (GPS) and computer terrain modeling technology and how these might be combined to provide for a Computer Aided Earthmoving System (CAES) verification of soil compaction and thicknesses of layers as they are being installed and undergoing compaction during each pass of the compaction equipment over placed loose lifts (e g , see Caterpillar 2003) Discuss advantages of this methodology compared to methods that involve acquiring data at a series of isolated points over the cover system footprint Further discuss soil density tests and independent land surveys for demonstrating the effectiveness of	UAC R313-24-4, 10 CFR 40 Appendix A, Criteria 1 and 4

TABLE 1. SUMMARY OF REQUIRED ADDITIONAL ANALYSES AND REMAINING TECHNICAL ISSUES

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		the CAES method, and procedures that may be used for visual monitoring of the CAES-verified compaction process and review of CAES-generated computer records for each layer of soil placed by on-site QC personnel. Provide more detailed discussion of companion sand cone tests and moisture tests to be performed along with nuclear tests until a sufficient number of have been performed to demonstrate a clear correlation between results obtained using these test methods.	
Proposed Cover Design and Construction Relative to Projected Cover Performance – Insufficient information is provided regarding the locations used by EFR for calculating cover settlement and regarding calculations of settlement.	EFR Responses to Round 1 Interrogatories 3/1 and 7/1 on Rev 5.0 Rec Plan (05/31/12 and0 8/15/12)	(See Sections 3.0 and 7.0 the Technical Memorandum for details) Clarify the distribution (locations) and range of different (calculated) differential settlement amounts across the tailings management area Provide information to permit the Division to independently identify the specific set of settlement monuments at which maximum differential settlement magnitude has been observed/projected, the distance between these settlement monuments, and the location within the tailings embankment where this maximum differential settlement is projected or has been observed to occur.	UAC R313-24-4, 10 CFR 40 Appendix A, Criteria 1 and 4
Filter and Rock Riprap Layer Criteria and Placement – Some additional criteria/requirements should be added to the CQA/CQA Plan with regard to rock riprap placement and testing to reflect applicable NRC guidance	EFR Responses to Round 1 Interrogatory 3/1 on Rev 5.0 Rec Plan (05/31/12 and 08/15/12 Section 5 of Attachment B, Construction Quality Assurance/Quality Control Plan, to the Reclamation Plan, Rev 5 0	(See Section 3.0 the Technical Memorandum for details) Incorporate proposed revised filter layer gradation and permeability criteria into the Construction Drawings and CQA/CQC Plan Incorporate proposed revisions to Section 5 7 1 of the CQA/CQC Plan and Section 8.2 4 of the Technical Specifications to include a required minimum thickness of the rock riprap layer equal to 1.5 times the D50 rock riprap diameter of 7 4 inches, or 1.0 times the D100 of the rock riprap materials, whichever is greater, to be acceptable.	UAC R313-24-4, 10 CFR 40 Appendix A, Criterion 1 and 4, NUREG-1623, Appendices D and F

TABLE 1. SUMMARY OF REQUIRED ADDITIONAL ANALYSES AND REMAINING TECHNICAL ISSUES

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		Revise the proposed procedures for placement of rock riprap for erosion protection to also indicate the following, based on NUREG-1623 guidance: • Initial testing is to be conducted to determine the gradation and the rock weight/unit volume that will be achieved in future rock placement activities, • No individual rock piece exceed 90% of the riprap layer thickness; • Dumped riprap should be placed to its full course thickness in one operation and in such a manner as to avoid displacing any underlying bedding Rearranging of individual stones by mechanical equipment or by hand may be required to the extent necessary to obtain a well-keyed and reasonably well-graded distribution of stone sizes and that larger pieces of riprap may require individual placement by equipment; and • Any stones that are not firmly wedged should be adjusted and additional selected stones inserted or existing stones replaced, so as to achieve a solid interlock	
Cover Test Pad/Test Section and Monitoring Program –	EFR Responses to Round 1 Interrogatory 14/1 on Rev 5 0 Rec Plan (05/31/12 and 8/15/12)	(See Section 14 0 the Technical Memorandum for details) On the basis of the considerations discussed in the Technical Memorandum, as a condition of approval of the Reclamation Plan, the Division requests the following. EFR will need to provide a detailed Technical Work Plan for Division review and approval, no later than 90 days after approval of the revised Infiltration and Contaminant Transport Modeling (ICTM) Report by the Division, for constructing, monitoring and testing a Cover Test Pad//Test Section, without irrigation, to be representative of the intended full-	UAC R313-24-4, 10CFR40, Appendix A

TABLE 1. SUMMARY OF REQUIRED ADDITIONAL ANALYSES AND REMAINING TECHNICAL ISSUES

ISSUE(S)	APPLICABLE REPORT SECTION(S) &/or INTERROGATORY RESPONSE ITEM(S)	REQUIRED ADDITIONAL PLANS, ANALYSES, &/or REVISION(S)	APPLICABLE REGULATORY CRITERIA AND GUIDELINES
		scale cover system. The Work Plan shall (1) provide a construction schedule, (2) provide details of the proposed Test Pad/Section's design and construction, (3) describe the proposed monitoring/testing program duration, (4) define parameters to be monitored/tested in the Test Pad/Test Section, (5) provide a schedule and details regarding reporting of monitoring and testing results, (6) describe objectives of the Test Pad/Test Section construction, monitoring, and testing program; and (7) propose and justify criteria for demonstrating that those objectives have been achieved. Without irrigation, the Test Pad/Test Section Work Plan will need to address acquisition of data for parameters (e.g.,volumetric percolation data, weather data, fertilization and nutrient content data and other soil testing, botanical data,...) to validate assumptions and predictions made by EFR with regard to the projected site-specific and cover-specific performance of the full-scale cover, including future emergence rates and characteristics of vegetation on the cover The Reclamation Plan must be revised to incorporate the information and requirements described herein with regard to this Test Pad/Test Section. EFR's proposal to maintain a rough surface on all but the uppermost lift in the cover is acceptable and EFR should incorporate this commitment into Attachment A of the next revision of the Reclamation Plan.	
BULK WASTE/RUBBLE/DEBRIS PLACEMENT AND SOIL/BACKFILL REQUIREMENTS			
Void Space Criteria – Controlling Residual Voids: Additional information needs to be provided in Attachment A regarding grouting practices to be	EFR Responses to Round 1 Interrogatory 4/1 on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Section 6 0 of Appendix G and Section 7.0 of	(See Section 4 0 the Technical Memorandum for details) Revise Attachment A to formalize the following	UAC R313-24-4/10CFR40, Appendix A, Criterion 4

TABLE 1. SUMMARY OF REQUIRED ADDITIONAL ANALYSES AND REMAINING TECHNICAL ISSUES

ISSUE(S)	APPLICABLE REPORT SECTION(S) &/or INTERROGATORY RESPONSE ITEM(S)	REQUIRED ADDITIONAL PLANS, ANALYSES, &/or REVISION(S)	APPLICABLE REGULATORY CRITERIA AND GUIDELINES
employed during rubble/debris placement.	Attachment A (Technical Specifications) of the Reclamation Plan, Rev 5.0	commitments made in the Response. (1) QA staff will observe construction practices to ensure that specifications for reducing void space within debris are met, (2) implement a "grouting program"; (3) QA staff will recommend to the Contractor to implement a grouting program in instances when voids, either within a debris mass, or within a vessel, cannot be properly filled with soil using conventional equipment"	
Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements – Insufficient criteria are provided to describe settlement stabilization requirements	EFR Responses to Round 1 Interrogatories on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Section 6 0 of Appendix G and Section 7.0 of Attachment A (Technical Specifications) of the Reclamation Plan, Rev. 5.0	(See Section 4 0 the Technical Memorandum for details) Provide a criterion for conditions that must exist before the final cover system may be constructed requiring that observed settlement has stabilized according to some reasonable criterion.	UAC R313-24-4/10CFR40, Appendix A, Criterion 4
Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements – Additional information is needed to support EFR's statements regarding organic material waste to provide assurance the cover system integrity will not be compromised	EFR Responses to Round 1 Interrogatories on Rev 5.0 Rec Plan (05/31/12 and 8/15/12) Section 6 0 of Appendix G and Section 7 0 of Attachment A (Technical Specifications) of the Reclamation Plan, Rev. 5.0	(See Section 4.0 the Technical Memorandum for details) Provide additional information to support the claims that organic materials will be a small percentage of all waste being disposed of, that biodegradation is not anticipated to compromise the cover system, and to provide confidence that the integrity of the cover system will not be compromised Provide additional information to support statements and provide confidence that the integrity of the cover system will not be compromised.	UAC R313-24-4/10CFR40, Appendix A, Criterion 4
Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements – Maximum Pipe Length	EFR Responses to Round 1 Interrogatories on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Section 6 0 of Appendix G and Section 7.0 of Attachment A (Technical Specifications) of the Reclamation Plan, Rev. 5.0	(See Section 4 0 the Technical Memorandum for details) Revise attachment A to state the maximum pipe length if it is less than 20 feet	UAC R313-24-4/10CFR40, Appendix A, Criterion 4
Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements – A contingency plan needs to be provided to address measures to be taken in the event that quantities of debris, rubble,	EFR Responses to Round 1 Interrogatories on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Section 6 0 of Appendix G and Section 7.0 of Attachment A (Technical Specifications) of the	(See Section 4.0 the Technical Memorandum for details) Discuss contingency measures to be taken that address the possible scenario mentioned in	UAC R313-24-4/10CFR40, Appendix A, Criterion 4

TABLE 1. SUMMARY OF REQUIRED ADDITIONAL ANALYSES AND REMAINING TECHNICAL ISSUES

ISSUE(S)	APPLICABLE REPORT SECTION(S) &/or INTERROGATORY RESPONSE ITEM(S)	REQUIRED ADDITIONAL PLANS, ANALYSES, &/or REVISION(S)	APPLICABLE REGULATORY CRITERIA AND GUIDELINES
and contaminated soil are insufficient to allow Cell 1 to be closed as planned.	Reclamation Plan, Rev. 5.0	Attachment A of the RecPlan Rev 5 0, namely that "relative quantities of debris, rubble, and contaminated soil are insufficient to allow Cell 1 to be closed as planned."	
Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements – The information presented in Attachment A is not sufficient to ensure/require that measures will be taken to ensure the void spaces inside debris items will be sufficiently filled	EFR Responses to Round 1 Interrogatories on Rev 5.0 Rec Plan (05/31/12 and 8/15/12) Section 6 0 of Appendix G and Section 7.0 of Attachment A (Technical Specifications) of the Reclamation Plan, Rev. 5 0	(See Section 4.0 the Technical Memorandum for details) Incorporate the statement "The voids on the inside of the item shall be filled with contaminated soil, clean fill soil, or grout (controlled low-strength material, flowable fill, etc). Contaminated soil (Section 7.3 3) or clean fill will be placed outside of the items and compacted with standard compaction equipment (where possible) or hand-operated equipment to the compaction requirements in Specification Section 7.4 " Require measures be taken to ensure that voids inside debris items are filled	UAC R313-24-4/10CFR40, Appendix A, Criterion 4
Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements – The information presented in Attachment A is not sufficient with regard to how required strength for hydraulic properties of the contaminated soil will be achieved and what formulation is likely to produce the desired outcome	EFR Responses to Round 1 Interrogatories on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Section 6.0 of Appendix G and Section 7 0 of Attachment A (Technical Specifications) of the Reclamation Plan, Rev 5 0	(See Section 4 0 the Technical Memorandum for details) Provide more specific information on how required strength for hydraulic properties of the contaminated soil will be achieved and what formulation is likely to produce the desired outcome	UAC R313-24-4/10CFR40, Appendix A, Criterion 4
SEISMIC HAZARD EVALUATION			
Design Basis Seismic Event – An updated probabilistic seismic hazard assessment (PHSA) has not been conducted, Some errors and uncertainties associated with the current evaluation also need to be rectified/addressed.	Attachment A to Denison 2012a. EFR Response to Round 1 Interrogatory 5/1 on Rev 5 0 Rec Plan (5/31/12 and 8/15/12)	(See Section 5 0 the Technical Memorandum for details) EFR should perform a site-specific PSHA as previously requested Adjust the cited USGS National Hazard Map PGA value of 0 15 g for the site Vs30 as appropriate Rectify error in statements provided that the site-specific Vs30 (time-averaged shear-wave velocity	UAC R313-24-4/ 10CFR40, Appendix A

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		in the top 30 m) as determined by Tetra Tech (2010) was 586 m/sec corresponding to a NEHRP site class E or soft soil, and in selection of corresponding NEHRP site class Further address uncertainties associated with the inferred Vs Provide the technical basis for the Vs for the remaining 20 m of interbedded sandstone referenced in the Response. Characterization of the site as a thin soil site where there is 10 m of soil over firm (?) rock (Tetra Tech, 2010) indicates that a site response analysis is now warranted to address site effects on ground motions. A site response analysis with a Vs profile into the rock should be performed	
COVER/ TAILINGS EMBANKMENT DESIGN ANALYSES			
Slope Stability – A revised stability analysis should be provided that addresses several items relating to the appropriateness of, and justification for, assumptions and parameters used in the analysis.	• EFR Responses to Rd 1 Interrogatory 06/1 on Rev 5 0 Rec Plan (05/13/12 and 8/15/12) • Attachment D Supporting Documentation for Interrogatory 06/1: Revised Appendix E, Slope Stability Analysis, to the Updated Tailings Cover Design Report	(See Section 6 0 the Technical Memorandum for details) Provide a revised slope stability analysis to adequately address several considerations and criteria that may be important to the stability analysis of the tailings embankment, including the following: • Shear strength data for the liner and LCRS components in Cells 4A and 4B; • How the bottom liner component(s) was (were) simulated in the global stability analysis completed for cross Section A through Cell 4B; • Shear strength data for the liner and LCRS components in Cell 2; • How the bottom liner component(s) was (were) simulated in the global stability analysis completed for cross Section B through Cells 2 and 1, Provide sufficient information regarding:	UAC R313-24-4/10CFR 40 Appendix A, Criterion 1, NUREG-1620, Section 2 2 3

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		1) The estimated in-place dry density, in-place most density, and in-place saturated density (unit weight values) of the tailings, 2) Rationale for selecting the tailings condition and tailings properties assumed in the analysis (e.g , drained vs. undrained conditions and for selection of in-place moist tailings density vs in-place saturated tailings density for long-term static conditions or long-term seismic conditions); and 3) The location of the assumed water table, e g , if drained condition assumed; and 4) Rational for assumptions and for selection and use of other parameters as discussed in Section 6 3 of the technical Memorandum Further define, in Attachment D, how the tailings total unit weight value stated in Table E 1 (90 pcf) and used in the revised slope stability analysis was derived (or how representative a value that value is of the tailings). Reevaluate and verify that the assumed tailings properties, calculation methodologies, and assumptions are representative, reasonably conservative, and bounding.	
Minimize Infiltration/Encourage Runoff [Note See also summary table in "Technical Memorandum – White Mesa Mill Site Revised ICTM Report Review"] – The currently proposed ET cover design does not adequately ensure that infiltration rates into the tailings will be continue to be minimized throughout the cover's performance period of 200 to 1,000 years, given the likely/ potential effects of a range of future postclosure external environmental, biogenic/ biological, and physical processes on the cover, and geomechanical effects of potential differential settlement in tailings cells, especially Cells 2 and 3, on cover slopes	• Section 3 and Appendix D and Drawings TRC-1 through TRC-8 of Rev 5 0 of Rec Plan (September 2011) • EFR Response to Rd 1 Interrogatory 07/1 on Rev 5 0 Rec Plan (8/15/12), including Attachment E, and • Figure G-1 of Attachment G of EFR Response to Rd 1 Interrogatory 11/1 on Rev 5 0 Rec Plan (8/15/12)	(See Section 7 0 of the Technical Memorandum for details) EITHER Incorporate a capillary break component in the cover, or alternatively, provide detailed analyses and additional infiltration sensitivity analyses demonstrating that a capillary break is not warranted; Incorporate a specifically designed biointrusion barrier component into the cover design; and	UAC R313-24-4/10CFR 40 Appendix A, Criterion 4, NRC 2003a, Sections 2 3, 2 7, and 4 1

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		EITHER Increase the inclination of the proposed cover topslopes, especially over tailings Cells 2 and 3, to a minimum of 2-3 %, OR (1) provide detailed consolidation and 2D/3D numerical settlement analyses to demonstrate that future differential settlement will not result in slope reversal/ponding at any location in the proposed cover; and (2) Conduct compacted clayey soil laboratory distortion tests to demonstrate that future differential settlement will not compromise the physical integrity and continuity of the cover system throughout the cover's performance period of 200 to 1,000 years; and (3) provide additional data, analyses, and information required under "Cover Constructability" (row 1 of this table) that satisfactorily justifies/support the contention that the currently proposed cover system having such extremely flat topslope inclinations can be constructed uniformly and reliably over the entirety of the currently proposed topslope area	
Settlement Analyses and Potential for Cover Slope Reversal and/or Cover Layer Cracking – The potential impacts of differential settlement and liquefaction on the integrity of the compacted clayey soil layer of the proposed ET cover system have not been adequately determined.	Appendix D, Updated Tailings Cover Design Report of the Rev 5 0 Rec Plan, and Drawings TRC-1 through TRC-8 in the Rev 5 0 Rec Plan (September 2011) EFR Response to Rd 1 Interrogatory 07/1 on Rev 5 0 Rec Plan (08/15/12 and 08/31/12) Attachment E, Supporting Documentation for Interrogatory 07/1. Updated Settlement Analyses (Undated)	(See Section 7 0 the Technical Memorandum for details) Use site-specific data to supplement assumed or extrapolated/curve-fit settlement data. Discriminate between differences in settlement monitoring data, remove skewing effects of possibly non-representative data, and do not use max., min , or average values based on unrepresentative data Account for the full range of different conditions that may occur within each of the tailings impoundment cells This includes consideration of tailings consistency (slimes versus sands) and spatial differences relative to cell geometry, depositional history, and drainage conditions More	UAC R313-24-4/10CFR 40 Appendix A, Criterion 4

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		rigorous analyses may be required to quantify the effects of these differences Provide clarifications regarding information missing or that is otherwise unclear in settlement analyses, including distances between settlement points used in differential settlement analysis the thickness of cover layer components, the time to end of primary settlement used in the secondary settlement analysis, how the settlement values "five years after placement of final cover" were calculated, how "zone" elevations were determined and how they relate to the drainage path lengths Provide calculation narratives (or at least illustrative equations and a description of how specific values were determined) Correct several errors and discrepancies in analyses, including several aspects of the seismically induced settlement calculations, concurrent primary and secondary settlements, and the water levels in tailing used in the different settlement analyses. Include the settlement effects of tailings located above water level in cells in total settlement estimates and assessment of cover performance. Compare seismically induced settlement calculations with those obtain using more established methods. Demonstrate that the results of settlement analyses are consistent with results of drainage/dewatering analyses, and ensure that drainage/dewatering analyses reflect the tailings and drainage conditions (including slime drain system) existing in each cell Address additional requirements related to dewatering analyses, measures, costs, and schedule for dewatering of Cells 2 and 3 as described under "Financial Surety Arrangements" below in this table and in Section 15.0 of the Technical Memorandum.	

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		Appropriately account for the effects of localized bending in the cover cracking analysis Demonstrate that the most critical case/condition for each of the Cells is accounted for Clearly indicate and justify the bending profile used in the analysis.	
Long-Term Erosion Protection [Note See also summary table in "Technical Memorandum – White Mesa Mill Site Revised ICTM Report Review"] – Existing erosion protection calculations and assumptions are considered valid only if (1) uniform grading will have been achieved during construction, and (2) Differential settlement has been shown to be insignificant.	• EFR Responses to Rd 1 Interrogatory 08/1 on Rev 5 0 Rec Plan (05/13/12 and 8/15/12) • Attachment C Supporting Documentation for Interrogatories 02/1 and 08/1: Revised Appendix G, Erosion Stability Evaluation, to the Updated Tailings Cover Design Report (Appendix D of RecPlan, Rev. 5 0) (August 2012)	(See Section 8.0 the Technical Memorandum for details) EITHER Provide additional detailed information and data that demonstrate that (1) The proposed ET cover can be constructed to a uniform grade throughout its entire surface area; (2) Differential settlement will be insignificant; and (3) Slope reversal/potential ponding of surface water on covers for other tailings repository cover systems that have been constructed to a similar range of topslope inclinations and surface areas to those proposed has not, and will not, occur during the 200 – 1,000 year-long required performance period of those covers; OR Increase the inclination in the proposed ET cover, especially over tailings Cells 2 and 3, to a minimum of 2-3%.	UAC R313-24-4/10CFR 40 Appendix A, Criterion 4; NUREG-1623, Section 2 4
Liquefaction Analyses – The potential impacts of differential settlement and liquefaction on the integrity of the compacted clayey soil layer of the proposed ET cover system have not been adequately determined	• Appendix D, Updated Tailings Cover Design Report of the Rev 5.0 Rec Plan, and Drawings TRC-1 through TRC-8 in the Rev 5.0 Rec Plan (September 2011) • EFR Responses to Rd 1 Interrogatory 09/1 on Rev 5 0 Rec Plan (05/31/12 and 08/15/12) • Attachment F, Supporting Documentation for Interrogatory 09/1· Updated Liquefaction Analyses (Undated)	(See Section 9.0 the Technical Memorandum for details) Use site-specific data in analyses (e.g , not assumed SPT blowcounts); otherwise use the most reasonably conservative values possible in all calculations. Consider the range of tailings properties when performing the analyses. Do not use average values, particularly for fines content Use consistent characterization of the tailings across	UAC R313-24-4/10CFR 40 Appendix A, Criterion 1

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		slope stability, settlement, and liquefaction analyses, particularly with respect to unit weights Use the parameter K_σ which accounts for effects of confining stress in the liquefaction analyses Resolve apparent inconsistencies regarding thickness of cover system components and tailings thickness in the different Cells. Explicitly relate the results of the tailings dewatering analysis to the water levels used in the liquefaction analyses and demonstrate that they are consistent	
Frost Penetration Analysis [Note· See also "Inconsistencies between Revised ICTM Report and Reclamation Plan, Revision 5 0" in summary table in "Technical Memorandum – White Mesa Mill Site Revised ICTM Report Review"] – A revised emanation modeling sensitivity analysis (as well as a revised infiltration modeling sensitivity analysis) should be performed for the approved final cover for a scenario that incorporates adjusted bulk density and porosity values for soils in the upper zone of the cover system potentially impacted by the predicted maximum frost penetration	Attachment C of EFR Response to Rd 1 Interrogatory 10/1 on Rev 5.0 Rec Plan (05/31/12)	(See Section 10 0 the Technical Memorandum for details) Conduct revised infiltration and revised radon emanation modeling sensitivity analyses for the approved final cover for a scenario that incorporates adjusted bulk density and porosity values for soils in the upper zone of the cover system potentially impacted by the predicted maximum frost penetration Adjusted soil property values used in the simulations should either consist of adjusted values derived in a manner consistent with NRC recommendations for adjusting such properties in frost-impacted soils for radon flux emanation calculations or adjusted values derived/assigned in manner consistent with recommendations provided in Benson et al 2011, whichever is more conservative for each type of simulation	UAC R313-24-4, 10CFR40, APPENDIX A, Criterion 6, NRC 2003a, Section 5 1 3
Cover Revegetation Plan Objectives, Goals and Details/ Anticipated Effectiveness of Vegetation in Promoting Evapotranspiration in ET Cover [Note· See also summary table in "Technical Memorandum – White Mesa Mill Site Revised ICTM Report Review"] – The information presented is not sufficient to demonstrate that vegetation cover will be sustainable over the long	EFR Response to Round 1 Interrogatory 11/1 on Rev 5 0 Reclamation Plan (08/15/12) Attachment G, Revised Appendix D, Vegetation and Biointrusion, to the Updated Tailings Cover Design Report , August 2012	(See Section 11.0 the Technical Memorandum for details) Provide information on current vegetation on previously revegetated areas at the White Mesa Mill Site and the history of revegetation efforts and results at the site. Provide more detail on the results of vegetation surveys conducted in June 2012 (see	UAC R313-24-4/10CFR 40 Appendix A

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term and that it will be effective in promoting evapotranspiration Additional information also needs to be provided to support/defend the range of root density values listed in Table 01/3-1 of EFR's Response to Rd 1 Interrogatory 1 on the Revised ICTM Report		also discussion under "Biointrusion (Cover) Hazard Evaluation" in the next row of this table). Provide a map of current vegetation Provide information on soil properties at reference areas to document that "sustainable levels" are achievable Provide additional information on procedures to be used during soil amendment and weed management practices to be employed. In the discussion of succession, address regionally common shrub species that may colonize the site from lower elevation, warmer and drier sites. Provide example root density calculations showing how estimated root density values were derived Re-evaluate/ further demonstrate that use of specific information referenced by EFR for deriving estimated root densities in soil is/appropriate for the semi-arid conditions at the site Revise the root density estimation approach and range of estimated root densities as needed based on this re-evaluation Please provide· (1) definition of clear, concise, and measurable revegetation acceptance goals/criteria for the vegetation establishment on the tailings cell cover system, (2) a description of how EFR will conduct periodic post-closure monitoring and reporting to the Division of the vegetation community health, viability, success, and sustainability, (3) a description of proposed action plans, schedules and deadlines for remedial actions if/when needed to effectuate plant community success, and (4) information on similar follow-up monitoring of the plant community/cover system to ensure successful performance before release of the facility's surety bond and/or transfer of title to DOE. EFR should describe and support specific, quantitative goals for shrub establishment (including rooting depths and minimum acceptable shrub cover percentages) that consider the need for deeper rooted plants to remove water that may accumulate lower in the cover profile in response to an exceptionally wet year or successive wet years,	

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		especially given the lack of a capillary break layer in the currently proposed cover design Describe corrective measures that may be needed to address/correct issues related to (1) establishment of undesirable species, e g., colonization by certain undesired grass/weedy species that may have more limited water stress tolerance than initially seeded grass species and/or that may outcompete planted grass species unless controlled ; (2) seed predation following seeding/reseeding efforts, (3) possible low success rates resulting from shrub establishment efforts, etc...Provide estimated costs for conducting these post-elosure activities, corrective actions, and reporting, once approved by the Division, in the financial surety estimate	
Biointrusion (Cover) Hazard Evaluation [Note See also summary table in "Technical Memorandum – White Mesa Mill Site Revised ICTM Report Review"] – No specific biointrusion barrier is proposed to be incorporated in the ET Cover Without a biointrusion barrier, the information presented in the EFR Response is not sufficient to demonstrate that biointrusion is unlikely to occur from shrub roots and burrowing mammals	EFR Responses to Round 1 Interrogatories on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Attachment G, Revised Appendix D, Vegetation and Biointrusion, to the Updated Tailings Cover Design Report, August 2012	(See Section 11 0 the Technical Memorandum for details) Provide documented, more detailed information on the results of plant and animal burrowing surveys completed at the site in June 2012, and provide additional discussion and analysis of those findings in the context of relevant findings obtained from other similar sites having similar site environmental conditions, similar soil types, and similar plant and animal species and distributions, based on relevant literature Provide a range of data on reported burrowing depths and revisit maximum numbers of burrows to ensure that they have been accurately and conservatively stated Further address the range of rooting depths of shrubs that may colonize the revegetation areas Provide a literature review or observations to document that plant roots are unlikely to extend into compacted soils	UAC R313-24-4/10CFR 40 Appendix A
Radon Barrier Effectiveness – Additional issues related to the radon emanation modeling need to be further addressed/ resolved	• EFR Response to Round 1 Interrogatory 12/1 on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) • Attachment H, Supporting Documentation for	(See Section 12.0 the Technical Memorandum for details) Resolve the following issues regarding radon flux	UAC R313-24-4, 10CFR40, APPENDIX A, Criterion 6 (4)

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	Interrogatory 12/1: Revised Appendix C, Radon Emanation Modeling, to the Updated Tailings Cover Design Report (Appendix D of RecPlan, Rev 5 0) (August 2012)	modeling. 1) Address the dependence of radon emanation and diffusion coefficient on long-term moisture content (raised in Item d of INT 12/1) 2) Adequately explain the work presented in Attachment H, Attachment C 2. for the values used for long-term moisture content. Confirm the conclusion that values used in radon modeling are conservative. Complete the discussion of values of long-term moisture content used in radon modeling. 3) Resolve inconsistencies between values in Table C-4 for diffusion coefficients vs. those in Attachment H, Attachment C.3 4) All calculated Radon fluxes from the surface of the cover system (Layer 5) exceed 20 pCi/cm2-s, albeit be very slight amounts Please address the apparent failure of the proposed cover system design to satisfy the regulatory constraint for radon flux	
SITE RECLAMATION/DECOMMISSIONING, RADIOLOGICAL SURVEYS/ SITE DECOMMISSIONING COST ESTIMATES			
Concentration of Radionuclides Other Than Radium	EFR Responses to Round 1 Interrogatories on Rev 5 0 Rec Plan, 5/31/12 and 8/15/12	(See Section 13.0 the Technical Memorandum for Details) Provide the following • Justification (either data or references to data) to support EFR's determination of U-nat and Th-230 background concentrations, • A description of how EFR's site-specific sampling program will be used to determine background concentrations for radionuclides other than Ra-226 into EFR's documentation of how MARSSIM will be implemented and submit for the Division's review,	UAC R313-24-4, 10CFR40, APPENDIX A, Criterion 6(6)

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		• A description of how EFR will use the "sum rules" for surface and subsurface soils into EFR's documentation of how MARSSIM will be implemented and submit for the Division's review; • A description of EFR's plan for using radiation measurement instrumentation for soil background analyses, radium-gamma correlations, verification data, and sensitivity analyses into EFR's documentation of how MARSSIM will be implemented and submit for the Division's review, and • Documentation of how MARSSIM will be implemented descriptions of ✓ Calibration procedures ✓ Instrument testing ✓ Detection limits of sample analyses ✓ Extent of expected contamination ✓ Limits of gamma survey ✓ Verification of the soil-radium gamma correlation	
Financial Surety Arrangements - Decommissioning, Stabilization, and Reclamation Cost Estimates. EFR must submit and receive approval of its revised cost estimates before the Division will approve EFR's proposed and revised cover system design EFR also has inadequately addressed the time required to dewater Cell 2 and Cell 3.	EFR Responses to Round 1 Interrogatory 15/1 on Rev 5.0 Rec Plan (05/31/12 and 08/15/12)	(See Section 15 0 of Technical Memorandum for details) EFR will need to submit and receive approval of revised decommissioning, stabilization, and reclamation cost estimates In order to address uncertainties associated with the time required to dewater Cells 2 and 3 prior to constructing the final cover, the Reclamation Plan needs to include technically supported quantitative projections, including uncertainty and sensitivity analyses that account for known and likely uncertainties in input parameters, and that	UAC 10CFR40, APPENDIX A, Criterion 9

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		demonstrate that dewatering of Cells 2 and 3 will be accomplished within the 7-year time period specified in the latest submitted Financial Surety submitted to the Division (see also Section 7 3 of the Technical Memorandum), or a shorter time period The Reclamation Plan needs to include a schedule for, and a detailed description of, dewatering measures that EFR will use to achieve, within this 7-year or shorter time period, tailings moisture contents upon which the final covers can be constructed with expectation that the dewatered tailings will not likely contribute to instabilities in the cover Costs of the specific dewatering measures need to be included in the Financial Surety.	
Unique Decommissioning Requirements – Radiation Protection Manual	EFR Response to Round 1 Interrogatory 16/1 on Rev 5 0 Rec Plan (05/31/12 and 8/15/12) Attachment D, Radiation Protection Manual for Reclamation	(See Section 16.0 of Technical Memorandum for details) EFR must revise the RPM to specify how the program will be modified to address the unique decommissioning requirements, or the process through which the manual and program will be revised in the future. EFR should also include procedures for gamma radiation surveys in the revised RPM that are discussed in the response document.	UAC R313-15-501
Decontamination Procedures and Disposal – Release Surveys	EFR Responses to Round 1 Interrogatory 17/1 on Rev 5.0 Rec Plan (05/31/12 and 8/15/12) Attachment D, Section 2 6, Release Surveys	(See Section 17 0 of Technical Memorandum for details) EITHER· (1) Cite previously submitted documents where these topics were addressed OR (2) Develop and submit for the Division's review	UAC R313-15-1002

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		and approval the following: ▪ Decontamination procedures for buildings and equipment ▪ Disposal of building components and equipment either on-site or off-site, depending on results of release surveys	
Inspection and Quality Assurance – Revised Technical Specifications need to be provided to allow Division approval of proposed modifications The responsibilities of the Radiation Safety Officer should also be further defined in the next revision of the Radiation Protection Manual	EFR Response to Round 1 Interrogator 18/1 on Rev 5.0 Rec Plan (05/31/12 and 08/15/12) Attachment A, Plans and Technical Specifications, Section 1.8b, Inspection and Quality Assurance	(See Section 18.0 of Technical Memorandum for details) Revise Section 1 8b of the Technical Specifications to indicate that the Division must review and approve all reclamation plan design modifications EFR needs to adequately define the responsibilities and duties of the Radiation Safety Officer in its next revision of the Radiation Protection Manual for Reclamation	UAC R313-12
Regulatory Guidance –	EFR Responses to Round 1 Interrogatory 19/1 on Rev 5 0 Rec Plan (08/15/12) Attachment A, Plans and Technical Specifications	(See Section 19 0 of Technical Memorandum for details) EFR should further revise the Reclamation Plan to reference and incorporate guidance provided in the documents listed below in the proposed technical specification modification revision request. • "Consolidated Decommissioning Guidance", NUREG-1757 • "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", NUREG-1575 • "Multi-Agency Radiation Survey and Assessment of Materials and Equipment (MARSAME)", NUREG-1575, Supplement 1	UAC R313-24; 10CFR40 42(J)

TABLE 1. SUMMARY OF REQUIRED ADDITIONAL ANALYSES AND REMAINING TECHNICAL ISSUES

ISSUE(S)	APPLICABLE REPORT SECTION(S) &/or INTERROGATORY RESPONSE ITEM(S)	REQUIRED ADDITIONAL PLANS, ANALYSES, &/or REVISION(S)	APPLICABLE REGULATORY CRITERIA AND GUIDELINES
Scoping, Characterization, and Final Surveys – Need to incorporate substance of responses into the Revised Technical Specifications or other documentation pertinent to the RecPlan	EFR Response to Round 1 Interrogatories 16/1 and 20/1 on Rev 5.0 Rec Plan (05/31/12 and 08/15/12)	(See Section 20.0 of Technical Memorandum for details) EFR needs to incorporate the substance of their responses to the individual items in this interrogatory into the further revised Technical Specifications or other documentation pertinent to the Reclamation Plan. EFR must also resolve the discrepancy in the schedules for calibrations in the Radiation Protection Manual and the Response as discussed in Section 20 3 of the Technical Memorandum. EFR should incorporate the information provided in responses to Items 2 through 9 into the further revised Technical Specifications or other documentation pertinent to the Reclamation Plan.	UAC R313-24, 10CFR40, APPENDIX A, Criterion 6(6)
OTHER ITEMS			
ACM Removal and Disposal Cost Estimate- – Revised cost estimates for removal and disposal of ACM identified at the site have been prepared but have not been included in the reclamation cost estimates.	EFR Responses to Round 1 Interrogatory 1/1 on Rev 5.0 Rec Plan (05/31/12 and 8/15/12)	(See Section 1 0 the Technical Memorandum for details) Include the additional costs of removing and disposing of ACM in the revised cost estimate for decontaminating and decommissioning the facility	UAC R313-24-4; 10CFR40 31(H)
Engineering Drawings – Revised Reclamation Plan providing revised information, analyses, calculations and engineered drawings will need to be submitted for Division review as committed by EFR	EFR Responses to Round 1 Interrogatory 2/1 on Rev 5.0 Rec Plan (05/31/12 and 08/15/12)	(See Section 2.0 the Technical Memorandum for details) Submit revised Reclamation Plan and associated documents that provide all information, analyses, calculations, drawings, and specifications, and procedures referred to in the Round 1 interrogatory responses Provide revised engineering drawings with the next revision of the Reclamation Plan	UAC R313-24-4, 10CFR40 Appendix A, Criterion 4

ATTACHMENT A Rev 5.0 Reclamation Plan Round 1 Interrogatories, Responses, and Discussion

1.0 Responses to Reclamation Plan Rev. 4.0 Interrogatories

1.1 Round 1 Interrogatory White Mesa Rec Plan Rev. 5.0; R313-24-4; 10CFR40.31(H); INT 01/1; Responses to Reclamation Plan Rev. 4.0 Interrogatories

The interrogatory requested the following:

The Division has reviewed the responses to Reclamation Plan Rev. 4.0 and is not asking for additional information at this time; however, the Division reserves the right and may submit comments and/or additional interrogatories following completion of review of the Denison Mines (USA) Corp (DUSA) response document dated December 28, 2011 (DUSA 2011).

1.2 EFR Responses to Rd 1 Interrogatory White Mesa Rec Plan Rev. 5.0; R313-24-4; 10CFR40.31(H); INT 01/1; Responses to Reclamation Plan Rev. 4.0 Interrogatories

IN ITS RESPONSE, EFR noted that in their response to this interrogatory that no response was required. EFR noted, however, that in response to this interrogatory, that a facility-wide inspection to determine the presence of asbestos in building materials in the milling facility would be conducted for Denison in the Spring of 2012. EFR used a qualified contractor to inspect the following four facilities at the White Mesa mill: Administration Building; Mill Building, Boiler Plant, Scale House, and Sample Plant; Maintenance-Warehouse Facility; and SX Building. These inspections identified (included in Attachment A to this Response) asbestos containing materials (ACM) as follows:

- *Administration Building – 9,745 square feet of floor tile and mastic*
- *Mill Building, Boiler Plant, Scale House, and Sample Plant – No ACM identified*
- *Maintenance-Warehouse Facility – 2,560 square feet of floor tile and mastic*
- *SX Building – 20 units of pipe fitting sealant*

EFR's contractor estimated to cost to remove and dispose of all ACM to total less than $50,000, not including technicians' travel expenses, cost for asbestos abatement design, and cost for management consulting services.

1.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa Rec Plan 5.0; R313-24-4; 10 CFR40.31(H); INT 01/1; Responses to Reclamation Plan Rev. 4.0 Interrogatories

The Division requests that EFR include the additional costs for removing the identified ACM in the estimate of costs to decontaminate and decommission the mill. The Division will review the revised reclamation cost estimates, when available, to verify that these costs have been included in the reclamation cost estimates.

2.0 Engineering Drawings

2.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40 Appendix A, Criterion 4; INT 02/1; Engineering Drawings

The interrogatory requested that EFR do the following:

Drawing REC-1: Provide design details for Discharge Channel.

Drawing REC-3: Provide design details for Discharge Channel. Identify the limits of the proposed Sedimentation Pond.

Establish and indicate on the appropriate drawing(s) the location of the main drainage channel. Demonstrate that the Cell 1 embankment and appurtenant apron are designed to remain stable under PMP conditions.

Drawing TRC-2: Correct the location shown by green dashes for the "Approximate limit of compacted cover,"

Drawing TRC-4: State where "Filter Layer" is defined. Link Rock Apron A and Rock Apron B to characteristics presented in the table at Detail 1/8.

Drawing TRC-5: In Sections A/3 and B/3, indicate the cover thickness to be 9 feet **minimum**. State the maximum tailings elevation on the North end of each section.

Drawing TRC-6: Please explain why the Compacted Cover cannot continue through the entire sections rather that terminating as "wedges".

Drawing TRC-7: Please explain why the Compacted Cover cannot continue through the entire sections rather that terminating as "wedges". State maximum slope on transitional slopes in Section A/3, B/3, and C/3 to be 5:1. State maximum tailings elevations in each section.

Drawing TRC-8: Revise both the Plan and the Elevation of Detail 1/8 to refer to the table provided below rather than stating D50 = 7.4" min. State where "Filter Layer" is defined. Show the "Riprap Filter Layer" on the side slopes of Details 3/5, Detail 4/8, and Detail 5/8 or otherwise resolve the conflict involving "Riprap Filter Layer" that exists between Detail 1/8 and the details cited. State where "Clay Liner" called out in Detail 4/8 is defined. Justify terminating the "Clay Liner" shown in Detail 4/8 at the exterior extreme (of top) of the "Radon Attenuation and Grading Layer". State the cover thickness shown in Detail 4/8 to be 9 feet minimum. Show the correct maximum tailings elevations in Details 6/8 (presently incorrectly stated) and 7/8 (presently not stated).

2.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40 Appendix A, Criterion 4; INT 02/1; Engineering Drawings

IN ITS RESPONSE, EFR indicated that Denison conducted a field investigation on April 19, 2012 to supplement existing soils data and further evaluate the geotechnical properties of the potential cover material. EFR indicated that laboratory testing on the collected samples from the April 2012 investigation was done in two phases. Phase 1 testing included Atterberg limits, specific gravity, and gradation (including hydrometer). Based on evaluation of the Phase 1 laboratory testing results for the April 2012 investigation and further evaluation of the laboratory testing conducted on samples from the October 2010 investigation, in addition to information provided by Benson (2012), the stockpile soils were categorized into four soil categories. The categories included topsoil, fine-grained soils, broadly graded soils, and uniformly graded soils. Select samples from the April 2012 investigation from these categories were selected for Phase 2 testing which included standard Proctor compaction, saturated hydraulic conductivity, and moisture retention tests.

EFR stated that the results of the 2010 and April 2012 laboratory testing were used to revise the technical analyses for the cover design, and that the resulting cover design is discussed in the Responses to Interrogatory 12/1. EFR committed to update the Drawings to reflect the revised cover design in the next revision of the Reclamation. EFR also provided narrative descriptions of a series of changes it intends to make to engineering drawings:

"The Drawings will be updated to provide design details for the Discharge Channel and identify the limits of the Sedimentation Pond.

The Cell 1 embankment and toe are designed to be erosionally stable from peak runoff from the PMP. Erosion protection is provided by riprap on the reclaimed slope of the Cell 1 embankment, and by a riprap apron at the toe of the embankment. The updated erosional stability analyses, including for the embankment and toe apron, are provided in Attachment C as a revised Appendix G that will be included in the next version of the Updated Tailings Cover Design Report (Appendix D of the Reclamation Plan).

Cell 1 will be cleaned of contaminated materials upon reclamation and the materials will be placed in the tailings cells. A portion of the Cell 1 area will be used for permanent disposal of contaminated materials and mill debris. The remaining area of Cell 1 will be breached and converted to a sedimentation basin. The Sedimentation Pond is designed to grade at a 0.1 percent slope northwest towards the Discharge Channel. This area is designed to be erosionally stable from peak runoff from the PMP with topsoil and vegetation. A rock apron is included at the transition between the vegetated surface of the Sedimentation Basin and the bedrock surface at the entrance of the Discharge Channel. Although channeling in this area would not cause erosional issues for the Cell 1 embankment, Denison has revised the grading to include a drainage swale along the center of the Sedimentation Pond area parallel to the toe of the Cell 1

embankment and draining to the west towards the Discharge Channel as shown in Figure G.1 of Attachment C.

The location of the "approximate limit of compacted cover" will change due to revisions to the cover design and the updated limit will be provided on Drawing TRC-2 in the next revision of the Reclamation Plan after approval of the conceptual cover design. The compacted cover was shown correctly as terminating as "wedges" on Drawings TRC-7 and 8 in Reclamation Plan Rev. 5.0. The compacted cover is the cover layer that will be compacted to 95 percent of standard Proctor dry density In some areas of Cell 2 and 3, the placed interim cover is thicker than required for the cover design and/or additional interim cover is required to meet grading requirements. As a result, there are areas in Cell 2 and 3 that do not require the compacted cover layer to meet radon emanation requirements. This is discussed further with the revised radon modeling results provided in Attachment H. A minimum compacted layer will be included for the final design and the drawings will be updated to incorporate this change as well as the revised cover design. A note will be added to the drawings to provide additional clarification.

Notes will be added to Drawing TRC-4 to clarify details on the filter and aprons provided on Drawing TRC-8.

A minimum cover thickness will be added to Drawing TRC-5 for Sections A/3 and B/3. The maximum tailings elevation will be added to the north end of Sections A/3 and B/3.

The maximum transitional slopes will be stated as 10H:1V on Drawings TRC-6 and TRC-7.

Drawing TRC-8 will be revised to reference the table for the Plan and Elevation of Detail 1/8. The filter layer and clay liner will be defined on Drawing TRC-8. The riprap filter layer will be added to the Details 3/5, 4/8, and 5/8. The termination of the clay liner will be revised to terminate at the bottom of the radon attenuation and grading layer and a 3-ft berm will be added at the termination location. The minimum cover thickness will be added to Detail 4/8. The maximum tailings elevations will be corrected for Detail 6/8 and will be added to Detail 7/8."

2.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40 Appendix A, Criterion 4; INT 02/1; <u>Engineering Drawings</u>

1. **Based on review of the above Response, the Division finds that although EFR provided narrative descriptions of the changes it intends to make to engineering drawings, revised drawings were not submitted with interrogatory responses. Rather, EFR committed to provide revised engineering drawings with the "next revision of the Reclamation Plan". The Division will review the revised engineering drawings, when available, to verify that these changes to the drawings have been made. Because EFR submitted neither revised engineering drawings nor the revised Reclamation Plan in its interrogatory response, this interrogatory will remain open.**

3.0 CQA/CQC Plan, Cover Constructability, and Filter and Rock Riprap Layer Criteria and Placement

3.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10 CFR 40 Appendix A, Criterion 1 and 4; INT 03/1; CQA/CQC Plan, Cover Constructability, and Filter and Rock Riprap Layer Criteria and Placement

The interrogatory requested that EFR do the following:

Refer to Section 5 of Attachment B, Construction Quality Assurance/Quality Control Plan, to the Reclamation Plan, Rev. 5.0: Please provide the following:

1. In Sections 5.3 and 5.4, clarify the nature and characteristics of wastes that would be placed into the reclaimed Cell 1 footprint area within which the 1-foot-thick compacted clay liner would first be installed. Verify whether and state consistently throughout the CQA/CQC Plan whether any uranium mill tailings materials would be placed into the clay-lined Cell 1 footprint area. If no tailings will be placed in the Cell 1 area, then change the name ("Cell 1 Tailings Area") given in the T.O.C., and Sections 1.1, 5.3, 5.4.2, and 5.6 of the CQA/CQA Plan to "Cell 1 Contaminated Soil and Demolition Debris Disposal Area" or other name as appropriate, and revise the descriptions of waste materials to be placed into the clay-lined Cell 1 area as needed throughout the CQA/CQC Plan to be consistent with the proposed disposal plan.
2. In Sections 5.6.4 and 5.6.5, provide a detailed justification to support the technical appropriateness and the constructability of the proposed topslope areas of the proposed cover system having such extremely flat slopes (e.g. 0.1 to 0.82 %). Provide information demonstrating that such topslope areas of the cover could be constructed with such shallow inclinations maintained continuously over the long distances that are required based on the currently proposed over design drawings such that no areas of runoff concentration or areas where ponding or could occur would result. Provide information justifying that appropriate required tolerances specified for final grades for ensuring conformance to the proposed extremely flat slope inclinations can be maintained and measured in the field with sufficient accuracy to ensure compliance with the specified slope requirements.
3. In Section 5.7.1.2, described material sampling frequency and filter gradation and filter permeability calculations (with associated acceptance criteria) that will be performed for the granular materials used in constructing the granular filter layer beneath the riprap layer on the sideslopes, to ensure that all applicable filter acceptance criteria will be achieved between the granular filter layer and each topslope cover layer component.
4. In Section 5.7.1, specify the minimum required thickness of the rock riprap layer on the sideslopes – equal to 1.5 times the D_{50} of the rock rip diameter of 7.4 inches, or the D_{100} of the rock rip rap materials, whichever is greater, as per NUREG-1623 (NRC 2002) –for clarity and transparency in the CQA/CQC process.
5. In Sections 5.7.2, 5.7.4, and 5.7.5 provide additional details regarding the minimum thickness for placed riprap layer material and requirements for using specialized

equipment or rearranging of rocks by hand, as needed, in accordance with the specified minimum required final thickness of the rock rip rap layer. Also provide additional details and requirements regarding procedures to be used to verify proper in-place rock riprap layer thickness and procedures for gradation testing in a completed initial riprap layer section, and for visual observations of the test section by field personnel. Provide criteria and procedures for testing additional test sections where observations suggest rock placement appears to be inadequate or where difficulties are experienced during rock place activities.

3.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40 Appendix A, Criterion 4; INT 03/1; CQA/CQC Plan, Cover Constructability, and Filter and Rock Riprap Layer Criteria and Placement

IN ITS RESPONSE, EFR provided the following information:

CQA/CQC Plan - EFR indicated that they will revise all sections of the CQA/CQC Plan, Technical Specifications, and the text of the Reclamation Plan itself to preclude placement of tailings into the Cell 1 Disposal Area, and to identify the Cell 1 area as the "Cell 1 Disposal Area" in all documents. EFR indicated that materials to be placed into this area will consist of contaminated materials and mill decommissioning debris.

Cover Constructability - EFR provided the following list of eight reclaimed uranium mill tailings repositories in the U.S. where either cover slopes or portions of cover slopes have been constructed at inclinations less than 1 %:

- *Falls City Title I site in Texas (less than 1% cover slopes)*
- *Bluewater Title II site in New Mexico (0.5 – 4% cover slopes)*
- *Conquista Title II site in Texas (0.5 – 1% cover slopes)*
- *Highland Title II site in Wyoming (0.5 – 2% cover slopes)*
- *Panna Maria Title II site in Texas (0.5% cover slopes)*
- *Ray Point Title II site in Texas (0.5 – 1% cover slopes)*
- *Sherwood Title II site in Washington (0.25% cover slopes)*
- *L-Bar Title II site in New Mexico (0.1% cover slopes)*

EFR also referred to a revised settlement analysis they completed in response to Interrogatory 07/01 (part of this Round 1 Response package) that indicated the following:

" the majority of the total settlement due to final cover placement and creep will occur within the first five years after placement of the final cover. During this time period, additional fill can be placed in any low areas in order to maintain positive drainage of the cover surface. Settlement occurring over five years after placement of the final cover ranges from 0.52 to 0.83 feet, with a maximum potential total differential settlement on the order of 0.31 feet. This estimated settlement is sufficiently low such that ponding is not expected to occur with a cover slope of 0.5

percent. In addition, it is not expected that the differential settlement is significant enough for slope reversal to occur."

Said response also included the following assessment:

"Cover cracking analyses were evaluated for the highly compacted radon barrier for the timer period after placement of the final cover. . . . The horizontal movement at the maximum tailing thickness is calculated to be 0.028 feet using a maximum thickness of relatively incompressible material of 4.7 feet, and a total differential settlement of 0.9 feet over 100 feet. The thickness of relatively incompressible material was estimated assuming a maximum 4.7-ft highly compacted radon barrier. The horizontal strain between any two settlement monitoring locations is the maximum horizontal movement divided by the horizontal distance (0.028 ft/100 ft). Using these values, the maximum horizontal strain is calculated as 0.028 percent. This value is lower than the maximum allowable strain of 0.05 percent. This indicates that cracking of the radon attenuation layer is not likely.

IN ITS RESPONSE, EFR provided additional filter gradation criteria in Attachment C to this Response package and indicated that Section 5.7.1.2 of the CQA/CQC Plan will be revised to include a testing requirement for particle size distribution testing prior to placement, using ASTM D-422. The recommended testing frequency is at least one test per 10,000 cubic yards of filter material placed, or when filter material characteristics show significant variation.

IN ITS RESPONSE, EFR indicated that Section 5.7.1 of the CQA/CQC Plan and Section 8.2.4 of the Technical Specifications will be revised to include a required minimum thickness of the rock riprap layer equal to 1.5 times the D_{50} rock riprap diameter of 7.4 inches, or the D_{100} of the rock riprap materials, whichever is greater.

In its RESPONSE, EFR also indicated the following:

- *Sections 5.7.2 and 5.7.4 of the CQA/CQC Plan will be revised to include reference to Section 5.7.1 for the minimum required thickness for the riprap layers (see Response 4 above).*
- *Section 5.7.2 of the CQA/CQC Plan will be revised to include the following text at the end of the section "Hand placing will be required only to the extent necessary to secure the results specified above."*
- *Section 5.7.4 of the CQA/CQC Plan will be revised to include the following text at the end of the section "Riprap layer thickness will be directly measured as outlined in Section 5.7.2. A measurement device (i.e. tape measure) may be used to determine the distance from the top of the bedding or filter layer to the top of the riprap layer."*
- *Section 5.7.2 of the CQA/CQC Plan will be revised to include the following text "An initial section of each type of riprap constructed shall be visually examined and used to evaluate future riprap placement. The initial section will be constructed with material meeting gradation and riprap thickness requirements; and*

- *Section 5.7.1.1 of the CQA/CQC Plan will be revised to include the following text at the end of the section "Gradations will also be performed at the direction of the QC Technician for any locations considered inadequate based on visual inspection by the QC Technician, or if difficulties are experienced by the Contractor during rock placement."*

3.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa Revised RecPlan 5.0; R313-24-4; 10CFR40 Appendix A, Criterion 4; INT 03/1; CQA/CQC Plan, Cover Constructability, and Filter and Rock Riprap Layer Criteria and Placement

The Division finds EFRs' Response to the first item of this interrogatory pertaining to materials to be placed into Cell 1 – i.e., EFR's commitment to revise all sections of the CQA/CQC Plan, Technical Specifications, and the text of the Reclamation Plan itself to preclude placement of tailings into the Cell 1 Disposal Area, and to identify the Cell 1 area as the "Cell 1 Disposal Area" in all documents – to be acceptable. These revised documents will need to be reviewed, when available, to verify that these changes have been made. Because these revised documents were not submitted in its interrogatory response, this interrogatory will remain open.

Based on its review of the section of EFR's response pertaining to the constructability of the currently proposed cover system having such extremely flat topslope inclinations, the Division is unable to concur with EFR's contention that such flat inclinations can be constructed uniformly and reliably over the entire required topslope area, as insufficient supporting information and justification have been submitted to satisfactorily support the contention. This issue needs to be addressed before appropriate conclusions can be reached.

In addition to the Division's uncertainties related to the constructability of the currently proposed cover, insufficient information has been provided in Attachment A (Technical Specifications, Section 8) and Attachment B (CQA/CQC Plan, Section 6) to the Rev 5.0 Reclamation Plan or in EFR's response regarding the means and procedures that would be implemented for controlling, verifying, and documenting layer thicknesses and final grades across the top portions of the cover. Examples of information missing that should be provided are discussions regarding the need for use of Global Positioning System (GPS) and computer terrain modeling technology and how these might be combined to provide for a Computer Aided Earthmoving System (CAES) for verification of soil compaction and thicknesses of layers as they are being installed and undergoing compacted during each pass of the compaction equipment over placed loose lifts (e.g., Caterpillar 2003). The advantage of this methodology is that it provides a continuous record in a continuous manner across the entire cover area footprint, rather than acquiring data at a series of isolated points. Discussions of soil density tests and independent land surveys for demonstrating the effectiveness of the CAES method, and procedures that may be used for visual monitoring of the CAES-verified compaction process and review of CAES-generated computer records for each layer of soil placed by on-site QC personnel, should also be provided. A more detailed discussion should also be provided of companion sand cone tests and moisture tests to be performed along with nuclear tests until a sufficient number of

have been performed to demonstrate a clear correlation between results obtained using these test methods. Similar procedures to those described here have been accepted and are in use at the Crescent Junction, Utah uranium tailings repository (e.g., see U.S. DOE-EM/GJ1547 [DOE 2012]).

The Division finds the filter layer gradation and permeability criteria and proposed construction quality assurance testing procedures and frequencies to be acceptable. The revised CQA/CQC Plan will need to be reviewed, when available, to verify that these changes have been made. Because the revised CQA/CQC document was not submitted in its interrogatory response, this interrogatory will remain open.

The Division also finds EFR's commitment to revise Section 5.7.1 of the CQA/CQC Plan and Section 8.2.4 of the Technical Specifications to include a required minimum thickness of the rock riprap layer equal to 1.5 times the D50 rock riprap diameter of 7.4 inches, or the D100 of the rock riprap materials, whichever is greater, to be acceptable. The revised CQA/CQC Plan and revised Technical Specifications will need to be reviewed, when available, to verify that these commitments will be faithfully implemented. Because these revised documents were not submitted in its interrogatory response, this interrogatory will remain open.

Based on review of the information provided in the Response with respect to rock riprap placement and construction quality assurance testing, the Division notes that EFR did not address certain additional specific recommendations included in Appendix F (Rock Placement Procedures for Erosion Protection) of NUREG-1623 (NRC 2002) in their response to this interrogatory, but which should be addressed. Additional NUREG-1623 recommendations that should also be addressed/ implemented include the following:

- **Initial testing should be conducted to determine the gradation and the rock weight/unit volume that will be achieved in future rock placement activities.**
- **No individual rock piece should exceed 90% of the riprap layer thickness**
- **Dumped riprap should be placed to its full course thickness in one operation and in such a manner as to avoid displacing any underlying bedding material**
- **It should be declared that rearranging of individual stones by mechanical equipment or by hand may be required to the extent necessary to obtain a well-keyed and reasonably well-graded distribution of stone sizes and that larger pieces of riprap may require individual placement by equipment.**
- **Any stones that are not firmly wedged should be adjusted and additional selected stones inserted or existing stones replaced, so as to achieve a solid interlock.**

Based on its review of the section of EFR's response pertaining to settlement and of the referenced revised settlement analyses, the Division is unable to assess the correctness of EFR's conclusion regarding cover performance with respect to settlement due to errors, omissions, discrepancies, and insufficient information in the materials submitted. These issues need to be addressed before appropriate and reliable conclusions can be reached. These issues are more fully discussed in Sections 7.0 and 9.0 below relative to the response

to Interrogatory 07/01, Technical Analysis - Settlement and Potential for Cover Slope Reversal and/or Cover Layer Cracking and 09/01, Technical Analysis - Liquefaction. Evidence should also be provided that the eight UMTRCA repository sites (which EFR claims have slopes similar to the 0.5 to 1% slopes proposed for the subject site) have performed adequately and that demonstrates that future differential settlement of those repositories during the 200- 1,000 –year performance period of those facilities will not occur to a degree that flattening/slope reversal of the topslope portions of those covers would result. Such information should include currently observed differential settlements and predictions of future settlements calibrated to the observed performance.

4.0 Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements

4.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40, APPENDIX A, Criterion 4; INT 04/1; Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements

The interrogatory requested that EFR do the following:

Refer to Section 6.0 of Appendix G and Section 7.0 of Attachment A (Technical Specifications) of the Reclamation Plan, Rev. 5.0:

a. Please define and justify a maximum void space percentage that will be allowed when disposing of demolition and decommissioning debris fragments and rubble in Cell 1.

b. Describe, in detail, construction practices that will enable satisfying this specified limit;

c. Please provide detailed procedures that will be used to control residual voids to meet the specified maximum allowable void space percentage(s) and a description of the specific construction quality assurance / quality control and verification procedures to be used to demonstrate that the void space criteria will be achieved;

d. Demonstrate how the percentage of allowable void space relates to the settlement analyses performed to evaluate the effectiveness of the procedures for placing debris fragments and rubble, placement of backfill in/around/under debris items, and compaction of the debris/backfill materials, for precluding the potential for slope reversal in the Cell1 cover system. Please also refer to "INTERROGATORY WHITEMESA RECPLAN REV. 5.0; R313-24-4; 10CFR40 APPENDIX A; INT 07/1: TECHNICAL ANALYSIS - SETTLEMENT AND POTENTIAL FOR COVER SLOPE REVERSAL AND/OR COVER LAYER CRACKING";

e. Please further define the characteristics of, and estimate the percentage of organic materials (including, for example, wood, branches, roots, paper, and plastic), expected to be disposed of. Provide specifications and procedures for disposing of organic materials such that long-term biodegradation of the disposed organic materials will not compromise the integrity and stability of the cover system;

f. Please provide detailed specifications for segmenting and placing metallic waste materials in layers so that structural shapes or other large pieces will not lie across or on top of each other. Please indicate that placement of metallic materials will allow large voids to be minimized and filled with soil. Please address special handling and disposal procedures for oversized and/or odd-shaped steel materials, including cutting or trimming dimensions before positioning for burial, and placement procedures to ensure that no large "slip planes" will occur within the disposal mass. Specify maximum allowable lift thickness for such material placement. Please also describe shredding, cutting or trimming procedures required to ensure that such materials following shredding, cutting or trimming can be placed within the specified allowable layer thickness;

g. Provide additional details of type of materials and placement practices, including specific dimensions of all demolition debris expected to be disposed of in Cell 1. Please justify that items needing to be size-reduced prior to disposal will in fact be size reduced. Provide additional information to justify that a maximum allowable size of dismantled or cut materials of 20 feet in the longest dimension (as proposed) and a maximum volume of 30 cubic feet are acceptable criteria for placement of such objects in a disposal cell;

h. Please provide a contingency plan to address the situation in which an insufficient quantity of demolition debris and rubble and contaminated soil would be available to fill the Cell 1 footprint area to a sufficiently high final waste grading configuration to provide a smooth, continuous transition between the completed Cell 1 cover system and the Cell 2 cover system, with no sudden, abrupt changes in slope between the two cover systems. Discuss means and methods that will be used, regardless of achieved final debris/rubble/contaminated soil placement grades, for ensuring that a smooth cover slope transition will occur between these two cell area cover systems;

i. Clearly and consistently define procedures/specifications for backfilling of interior void spaces inside debris objects (e.g., backfill of insides of smaller segmented pipe sections). Rectify apparent current inconsistencies between descriptions of backfill materials proposed for such use as described in Attachment A (e.g., controlled low-strength materials [CLSM] or flowable fill) and backfill materials for this use as described in Appendix (random fill materials). Provide rationale for selecting preferred backfill materials (e.g., CLSM) for different types and/or sizes of internal void space, as appropriate. For CLSM/ flowable fill, etc… used, provide information on the minimum required compressible strength of the material; and

j. Describe how the compressive strength requirement for CLSM or other grout backfill, in conjunction with the void space backfilling requirements and ultimate allowable void space and organic waste percentages relate to the design objectives for minimizing settlement of the backfilled Cell 1 area debris/rubble/backfill mass to preclude the possibility for long-term cover slope reversals.

4.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40, APPENDIX A, Criterion 4; INT 04/1; Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements

IN ITS RESPONSE, EFR responded individually to the ten issues raised in this interrogatory, as follows:

Response 1a (a) -The procedures for sizing and placement of debris were developed from mill demolition and debris placement at other uranium mill sites in the western US. The procedures reflected in the Technical Specifications were based on whether the demolition materials were compressible. These procedures are incorporated in the Technical Specifications, as summarized below.

Compressible materials are to be crushed and covered with soils, and incompressible materials are to be placed in the cell, with the void spaces outside of the materials filled with soils. Internal void spaces of incompressible materials are to be filled with soil where possible, or grout if needed.

Materials such as pipe and tubing have a varying degree of compressibility, depending on the diameter and wall thickness of the pipe. Pipe with a 12-inch diameter or larger is to be filled with grout or soil for burial, and pipe with smaller diameter was crushed before burial.

A requirement for the maximum void space percentage is not included because there is no practical method for measuring this percentage in the placed debris or the compacted soil during or after placement. Therefore a method specification reflecting best management practice from other projects was incorporated in the Technical Specifications.

Response 1b (b) - The debris is to be spread in a layer such that structural shapes or other large pieces do not lie on across or on top of each other, to prevent nesting. The soil to be used for filling voids around the debris is to be spread in loose layers over the debris, and worked into and around the debris materials until the void spaces are minimized. Enough soil should be placed so that the surface is accessible with tracked equipment. The debris is then walked with heavy tracked equipment to compress the debris as much as possible into the underlying soil. After additional soil fill placement, the soil and debris lift can be compacted with compaction equipment. From the proposed specifications:

"The debris, contaminated soils and other materials for the first lift will be placed to a depth of up to four feet thick, in a bridging lift, to allow access for placing and compacting equipment. The first lift will be compacted by the tracking of heavy equipment, such as a Caterpillar D6 Dozer (or equivalent), using at least 4 passes, prior to the placement of the next lift. Subsequent lifts will not exceed 12 inches and will be compacted using a minimum of 4 passes with the tracked equipment or a vibratory compactor.

The CQA technicians will monitor and approve of the final debris placement. In areas where voids are observed during placement, the contractor shall reexcavate the area, fill any voids encountered with soil and recompact the materials, or grout the voids."

Vessels and tanks will either be crushed (if thin-walled and compressible) or cut open (if thick-walled and incompressible). Vessels that are to be cut open and filled, will be placed in the cell such that fill can also be placed around them and compacted For thick-walled tanks or vessels that cannot be cut open due to cutting difficulties or worker health concerns with cutting these items open, these tanks or vessels will be placed in the designated area of disposal, with interior voids spaces grouted full.

Response 1c (c) - Quality assurance observation during fill and debris placement must be used to monitor the occurrence of voids that will require additional material to fill, or additional compaction of the debris layer. The contractor must ensure that debris is size-reduced to meet the specifications, so that it can be placed in the cell efficiently and without nesting or the occurrence of large voids. The Contractor will be required to repetitively attempt to make passes over the debris and fill voids with soil until the QA staff has determined that the voids are adequately filled, or an alternate method such as grouting will be required. The QA staff will make a recommendation to the Contractor for the implementation of a grouting program in instances when voids, either within a debris mass, or within a vessel, cannot be properly filled with soil using conventional equipment.

Response 1d (d) - Limiting the percentage of allowable void space within the debris fill will minimize the resulting settlement caused by the consolidation of the debris mass and the potential for slope reversal. However, the in-situ void characteristics of debris mass consisting of concrete and steel of various shapes and sizes, can be difficult to quantify for settlement analyses. The settlement analyses and any correlation to the percentage of voids within the debris will be discussed further in responses to that interrogatory.

It should be noted that the cover on top of the disposal cell will not be placed until settlement monitoring of the subsurface shows that anticipated settlement has taken place.

Response 1e (e) - The percentage of organic materials to be disposed of is anticipated to be a small percentage of the total material being disposed. Because the quantity of organics for disposal is minimal and because these materials are likely be mixed with incompressible debris and soil, the biodegradation of these materials is not anticipated to compromise the integrity of the cover system. Additionally, the organic materials will be spread throughout the disposal area which will minimize concentrated areas of compressible organic materials.

Organic debris should be size-reduced by crushing, chipping, or shredding prior to placement. As described in the Technical Specifications, organic material should only be placed in lifts less than 12 inches thick and should be mixed with the soil and other incompressible debris during placement to prevent pockets of organic material from being created. Organics mixed with soil

for spreading should be limited to 30% by volume of the mixture. This limit will be added to the Technical Specifications.

Response 1f (f) - The Contractor will select and place metallic debris by sizes so that larger pieces are not stacked on top of each other at angles. Large structural shapes will either be laid edge to edge so that they can be covered by soil that will fill in open spaces or they must be spaced far enough apart that equipment can operate between them to compact fill. As stated in the Technical Specifications, long structural (incompressible) members will be oriented horizontally. Metallic materials will be size reduced before placement and burial to a maximum dimension of 20 feet and a maximum volume of 30 cubic feet. Any metallic materials exceeding the specified dimensions will be cut or trimmed until they meet this specification.

Response 1g (g) - At this time the specific dimensions of all demolition debris expected to be disposed of is not available. These maximum allowable sizes of cut or dismantled materials have been specified for demolition of multiple uranium mill sites in the western US. While the specified maximum dimensions of 30 cubic feet, 20 feet for debris, and 10 feet for pipe, may be larger than the references cited (DOE, 1995, 2000), typically demolition is sized for the haulage equipment and often the individual pieces of debris will be less than these maximum dimensions in order to fit in trucks. Debris objects approaching 20 feet in length or 30 cubic feet are most likely to be long slender shapes which will have to be laid flat for disposal, or they are large blocky, or open vessel objects, which will be filled for placement. In either case, it is the method of placement in the cell and controlling the lift thickness, rather than the dimension of the debris that will determine the potential for excessive void spaces.

The references cited by the reviewer describe limiting the maximum volume to 27 cubic feet however only one of the references cited (DOE, 1995) includes a maximum dimension of 10 feet. The second reference, specifications for Weldon Springs Disposal Facility (DOE, 2000) does not include a maximum dimension for metal waste or large metal pieces, it states only that pipe stockpiled "...has been cut to 10 feet or less..." Based on our experience at other sites, and the review of the cited specifications, the proposed maximum length of 20 feet falls within the range of maximum lengths specified by the cited specifications. The proposed specifications include a maximum dimension of 20 feet for all debris and a 10-foot maximum dimension for pipes.

Response 1h (h) - If sufficient debris, rubble and contaminated soil is not available to fill Cell 1 as designed, the footprint of Cell 1 can be reduced in size so that the horizontal dimension extending out from the Cell 2 is reduced and the lateral extent of the disposed materials is reduced to be closer the base of the Cell 2 impoundment. This would allow the height of the cell to be maintained and the volume reduced, so that the cover slopes, as designed, will create a smooth, positive sloping transition from the Cell 2 to Cell 1. While it is unlikely that the volume of contaminated soil will be insufficient, if additional fill is needed to raise the elevation above the disposed material, clean fill could be used to establish proper positive drainage on the cover.

Response 1i (i) - The proposed procedure for filling void spaces, either within vessels, pipes that cannot be crushed (with a diameter of larger than 12 inches), or other miscellaneous voids, is to first attempt to fill the voids with soil. This would be done in the case of vessels by either placing soil through an existing opening, or cutting them open so that soil can be placed using the bucket of an excavator. Pipe sections, that cannot be crushed flat, can be cut short enough to stand on their ends, and then filled with soil from the bucket of an excavator.

To rectify the discrepancy between Attachment A and Appendix G, the language in the specification Section 7.3.6 of the Technical Specifications will be modified as follows:

"The voids on the inside of the item shall be filled with contaminated soil, clean fill soil, or grout (controlled low-strength material, flowable fill, etc.). Contaminated soil (Section 7.3.3) or clean fill will be placed outside of the items and compacted with standard compaction equipment (where possible) or hand-operated equipment to the compaction requirements in Specification Section 7.4."

For debris where internal voids cannot practically be filled with soil, a grouting program would be initiated to pump controlled low strength material (CLSM, flowable fill) into the voids. Debris would be grouped together and characterized as materials that would require grouting, so that a significant volume of debris can be grouted in a single action, rather than grouting individual lengths of pipe. Pipe sections could be stacked horizontally, or cut short enough to stand vertically in a safe manner. Grout would then likely be batched offsite and delivered to the site and a pump truck would likely be required to place the material within the debris, within the cell. A soil berm would be used to contain the grout laterally around the perimeter of the selected debris. The debris voids would be grouted, and grout would also be placed around the debris to develop a monolithic grouted mass.

The specified unconfined compressive strength of the CLSM would be between 30 psi (minimum) and 150 psi (maximum). Unit weights on the order of 100 to 120 pcf will be specified. These requirements will be added to the specifications.

Response 1j (j) - If CLSM is required for the grouting of voids that cannot be filled mechanically with soil, the mix design for the grout should mimic, as closely as possible, the strength and hydraulic properties of the contaminated soil that will also be used for filling voids within the debris. This will minimize any effects of differential settlement that would result from the grout having a higher strength and being less compressible than the surrounding soil.

4.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40, APPENDIX A, Criterion 4; INT 04/1; Void Space Criteria for Debris, Rubble Placement, and Soil/Backfill Requirements

The Division's assessments of these responses are summarized below.

a. Maximum Void Space Percentage: EFR does not state a maximum allowable void space due to the lack of practical means of quantifying residual void space following placement and backfilling. In lieu of stating a void space limit, EFR incorporates practices and requirements that were developed for the UMTRAP/UMTRCA and FUSRAP projects and that have been demonstrated effective in limiting settlement. EFR has developed and will implement method specifications that reflect best management practices, as documented in Attachment A "Plans and Technical Specifications for Reclamation of White Mesa Mill Facility; Blanding, Utah".

The practices call for compressible materials to be crushed or covered with soils (thus reducing residual void space), while voids in and around incompressible materials will be filled with soils or, if needed, grout.

The Division judges these specifications to be acceptable.

b. Construction Practices: Processing, placement, backfilling, and compacting of debris and organic material are discussed in Sections 7.3 and 7.4 of Attachment A "Plans and Technical Specifications for Reclamation of White Mesa Mill Facility; Blanding, Utah". According to these specifications:

- **Some larger items and items with internal voids will be size reduced to expose voids so they can be filled.**
- **Debris items will be placed to minimize nesting that could lead to residual voids after backfilling.**
- **Compressible debris will be flattened or crushed.**
- **Voids will be backfilled with soil, sand, or grout as judged appropriate by CQA Manager.**

These specifications constitute current best management practices and we judge them to be acceptable given current state of knowledge.

c. Controlling Residual Voids: EFR's QA staff will observe construction practices to ensure that specifications for reducing void space within debris are met. The interrogatory response includes a statement that "The QA staff will make a recommendation to the Contractor for the implementation of a grouting program in instances when voids, either within a debris mass, or within a vessel, cannot be properly filled with soil using conventional equipment".

No reference to a "grouting program" exists in Attachment A "Plans and Technical Specifications for Reclamation of White Mesa Mill Facility; Blanding, Utah". Attachment A should be revised to formalize this commitment.

d. Effects of Void Space on Settlement Analyses: EFR's response is given in its response to INT 07/1. EFR's response notes that the cover system will not be constructed ". . . until settlement monitoring of the subsurface shows the anticipated settlement has taken place."

An additional criterion should be added requiring that observed settlement has stabilized according to some reasonable criterion.

e. Percentage of Organic Materials: EFR's response makes several statements that, as far as we are able to determine, are not supported or documented:

- **"The percentage of organic materials to be disposed of is anticipated to be a small percentage of the total material being disposed."**
- **". . . the biodegradation of these materials is not anticipated to compromise the integrity of the cover system."**

EFR should provide additional information to support these statements and provide confidence that the integrity of the cover system will not be compromised.

1. Segmenting and Placing Metallic Waste Materials: Section 7.3 of Attachment A "Plans and Technical Specifications for Reclamation of White Mesa Mill Facility; Blanding, Utah" requires that larger debris items be size reduced, that larger pieces are not stacked on top of each other, that large structural shape either be placed edge to edge or spaced far enough that voids can be filled and equipment can operate between them, that the maximum dimension be 20 feet, that the maximum volume of any piece of debris be 30 cubic feet, and that long structural members be placed horizontally, and that any piece not satisfying these requirements be reworked.

These provisions are considered acceptable.

1. Types of Materials and Placement Practices: Section 7.3 of Attachment A "Plans and Technical Specifications for Reclamation of White Mesa Mill Facility; Blanding, Utah" places limits of 20 feet in length and 30 cubic feet in volume.

Although the interrogatory response mentions a maximum pipe length of 10 feet, this limit is not stated in the Attachment A. EFR should revise Attachment A to state the maximum pipe length if it is less than 20 feet.

f. Relative Quantities of Debris, Rubble, and Contaminated Soil: EFR should revise Attachment A to address the possibilities mentioned in the interrogatory response, should relative quantities of debris, rubble, and contaminated soil not allow Cell 1 to be closed as planned.

g. Backfilling Voids Inside Debris Objects: EFR proposes to revise Attachment A to incorporate the statement "The voids on the inside of the item shall be filled with contaminated soil, clean fill soil, or grout (controlled low-strength material, flowable fill, etc...). Contaminated soil (Section 7.3.3) or clean fill will be placed outside of the items and compacted with standard compaction equipment (where possible) or hand-operated equipment to the compaction requirements in Specification Section 7.4." EFR also describes measures that could be taken to ensure that voids inside debris items are filled. These include:

- **Filling the voids with soil through an existing opening**
- **Filling the voids with soil by cutting the item open**
- **Crushing the item flat (so no voids remain within**
- **Cutting pipes short, standing them on end, and filling them with soil**
- **Pumping controlled low-strength material (CLSM or grout) into a region to form a monolithic grouted mass**

These proposed revisions are acceptable and should be incorporated into Attachment A as proposed and other documents as appropriate.

h. CLSM Compressive Strength Requirements: EFR states that grout, if required, will be formulated to "mimic, as closely as possible, the strength and hydraulic properties of the contaminated soil that will also be used for filling voids within the debris."

EFR should state more specifically how these properties will be achieved and what formulation is likely to produce the desired outcome.

5.0 Seismic Hazard Evaluation

5.1 Round 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A; INT 05/1; Seismic Hazard Evaluation

The interrogatory requested the following:

Refer to Appendix E and Attachment E.1 to Appendix E to Appendix D, Updated Tailings Cover Design Report of the Reclamation Plan, Rev. 5.0: Please provide the following:

1. Please further clarify the rationale for selecting the annual probability of exceedance of hazard for the facility.
2. Adjust the cited USGS National Hazard Map PGA (peak ground acceleration) value of 0.15 g for the site Vs30 as appropriate.
3. Explain why the calculated hazard for the background earthquake PGA of 0.24 g was estimated but ignored in the recommendations provided in Appendix E.

4. Provide information to justify the use of 15 km distance for a background earthquake Mw 6.3 event.
5. Perform and report results of a site-specific probabilistic seismic analysis in lieu of using the USGS National Hazard Maps for developing site-specific seismic design parameters.

5.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A; INT 05/1; Seismic Hazard Evaluation

IN ITS RESPONSE, EFR indicated that previous seismic hazard analyses for the site evaluated peak ground acceleration (PGA) at the site for the operational life (MFG, 2006) and long-term reclaimed conditions (Tetra Tech, Inc. (Tetra Tech) 2010). The seismic hazard analysis by MFG (2006) compared the results of a deterministic seismic hazard analysis (DSHA) to USGS National Seismic Hazard Maps showing the peak ground acceleration (PGA) associated with a 2 percent probability of exceedance in 50 years, or a return period of 2,475 years. The projected operational lifetime of the most recently constructed tailings cell at the site is estimated to be approximately 50 years, from the time of construction through the time when the cell will have been dewatered and reclaimed. Therefore, use off a 2,475-year return period in formulating the probabilistic operational design criteria is considered conservative as this event has a 2-percent probability of exceedance over the anticipated 50-year operational design life.

EFR indicated that the seismic hazard analysis by Tetra Tech (2010) evaluated the PGA for long-term site conditions. Tetra Tech conducted a deterministic seismic hazard analysis and compared the results with the PGA associated with a 2 percent probability of exceedance during a 200-year design life, based on the USGS 2008 National Seismic Hazard Mapping Program (NSHMP) PSHA Interactive Deaggregation data. Two percent probability of exceedance during a 200-year period is equivalent to a return period of 9,900 years. The U.S. Environmental Protection Agency (EPA) Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites (40 CFR 192) and the NRC Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content (NRC 10 CFR Appendix A to Part 100 A) both specify that control of residual radioactive material must be effective for up to 1,000 years to the extent reasonably achievable, and for at least 200 years. Use of a 9,900-year return period in formulating the probabilistic design criteria for reclaimed conditions is considered conservative as this event has a 2 percent probability of exceedance during a 200-year period and a less than 10 percent probability of exceedance in a 1,000-year period.

In May 2012, EFR submitted a technical memorandum which EFR indicated represents a site-specific probabilistic seismic hazard analysis (PSHA) for both operational conditions and long-term reclaimed conditions for the site. This analysis was provided as Attachment A to Denison 2012a.

EFR indicated that the site Vs30 was calculated by Tetra Tech (2010) for the uppermost 100 feet of soil and bedrock underlying the site. The site-specific Vs30 was determined to be 586 m/s. This seismic velocity correlates to materials characterized as Site Class E – Soft Soil, by both the International Building Code (IBC) and the National Earthquake Hazard Reduction Program (NEHRP).

MWH Americas, Inc. (MWH), on behalf of Denison, checked Tetra Tech's calculation of Vs for the uppermost 100 feet of soils and bedrock underlying the site. The drilling logs by Tetra Tech (2010) and Dames and Moore (1978) were used to obtain information about the subsurface conditions at the site (Standard Penetration Test (SPT) blow counts, bedrock descriptions, and depths of auger drilling versus coring) and to calculate values of Vs for the soils and estimate values of Vs30 for the underlying bedrock materials.

EFR stated that the average value of SPT blow counts for the silty sand and soil material encountered in the top 30 feet of the Tetra Tech boring is 58.6 (Tetra Tech 2010). Using information in Sykora (1987) (eqs.20, 21 and Table 4 eq. 8) values of Vs30 were calculated to range from approximately 660 feet/second (ft/s) to 990 ft/s (approximately 200 to 300 meters/second (m/s)). This is also consistent with information presented in Fig. 5, Fig. 6, Fig. 10, and Table 8 of Sykora (1987). Based on the bedrock descriptions presented in the drilling logs by Dames and Moore (1978) to a maximum depth of 140 feet, the estimated seismic velocity for the remaining 70 feet of generally well-cemented sandstone with minor interbedded claystone, siltstone and conglomerate, is estimated to range from 800 to 1,000 m/s. A weighted average of seismic velocity for the upper 100 feet below the site was calculated to range from approximately 620 m/s to 700 m/s. This seismic velocity correlates with materials characterized as Site Class D – Stiff Soil by both the IBC and NEHRP.

EFR indicated that the NSHMP 2008 PSHA Interactive Deaggregation web site used by Tetra Tech to calculate the PGA for the site limits input values of Vs30 to either 760 m/s or 2,000 m/s. These seismic velocities correspond to Site Class BC (intermediate between dense soil and rock) and Site Class A (hard rock), respectively. Although the text that accompanies the PSHA program states that site-specific values of Vs30 can be input for sites in the Western US, the White Mesa site is considered to be located within the Central/Eastern United States for the program (Martinez 2012), and input values for Vs30 are limited to 760 m/s or 2,000 m/s. The available input value of Vs30 of 760 m/s is appropriate for the site-specific analysis based on the range of seismic velocity estimated for the site.

EFR also indicated that evaluation of the PGA due to a background earthquake unassociated with a known structure is typically included as a portion of a deterministic seismic hazard analysis. The analysis includes evaluating the potential for low to moderate earthquakes unassociated with tectonic structures to contribute to the seismic hazard of the site. The seismic hazard analysis performed by Tetra Tech included an evaluation of a background earthquake because it was a deterministic analysis. However, in order to evaluate the contribution from a background event in a deterministic analysis, one must estimate a likely magnitude and distance

from the site. Tetra Tech (2010) estimated a magnitude 6.3 event consistent with that used in previous seismic evaluations performed for sites in the Colorado plateau, and cited in their report. The 15km distance to a background earthquake was chosen as a distance which would provide a conservative PGA at the site.

EFR stated that the total seismic hazard at a site is better quantified by performing a probabilistic seismic hazard analysis to determine the likelihood of a specific ground acceleration occurring at the site within a given time frame (operational or reclaimed design life). EFR referred to the May 2012 probabilistic seismic hazard analysis for additional details.

EFR indicated that the site-specific PSHA for the Site determined that the PGA associated with a 2 percent probability of exceedance in 50 years, calculated for the operational lifetime of the facility, is 0.07g. The PGA associated with a 2 percent probability of exceedance in 200 years, calculated for the long-term reclaimed site conditions, is 0.15g. The details of the analysis are presented in Attachment A of the previous response document (Denison 2012a).

5.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A; INT 05/1; Seismic Hazard Evaluation

Results of the Division's review of EFR's Response to each individual interrogatory statement in this Round 1 interrogatory are summarized below.

As stated in the Basis for the Interrogatory and Round 1 Interrogatory statement #5, "The USGS National Hazard Maps should not be used for developing site-specific seismic design parameters (personal communication between Dr. Mark Petersen, Chief, National Seismic Hazard Mapping Project and Ivan Wong of URS Corporation, 2010) for critical and important facilities. For such types of facilities, a site-specific probabilistic seismic hazard analysis (PSHA) is recommended." However, contrary to this recommendation, Denison's consultant MWH in response used the USGS National Hazard Maps (specifically the interactive deaggregation tool) to recommend design ground motions for the facility. EFR did not perform a site-specific PSHA as requested. Use of the National Hazard Maps does not constitute a site-specific PSHA. The maps are four years old and are in the process of being updated. PSHA computer software such as EZFRISK® are readily available to perform a site-specific PSHA. Below are specific comments on EFR's responses to the interrogatory statements:

1. **Please further clarify the rationale for selecting the annual probability of exceedance of hazard for the facility.**

EFR has adequately responded to this statement.

2. **Adjust the cited USGS National Hazard Map PGA value of 0.15 g for the site Vs30 as appropriate.**

   EFR states that the site-specific Vs30 (time-averaged shear-wave velocity in the top 30 m) as determined by Tetra Tech (2010) was 586 m/sec corresponding to a

NEHRP site class E or soft soil. This is an erroneous statement. A Vs30 of 586 m/sec actually corresponds to a NEHRP site class C, very dense soil or soft rock. MWH also estimated the Vs30 for the site and concluded that the Vs30 ranged from 620 to 700 m/sec corresponding to a NEHRP site class D or stiff soil. This is also incorrect. This range in Vs30 also corresponds to a NEHRP site class C. Aside from these errors, the shear-wave velocity (Vs) estimate for the 10 m of soil appears reasonable although SPT does not measure Vs directly and so the uncertainties in the inferred Vs can be significant. However the technical basis for the Vs for the remaining 20 m of interbedded sandstone needs to be provided.

As stated above and in Statement 5, a request had been made not to use the National Hazard Maps but to perform a site-specific seismic hazard evaluation. The assumption that a site Vs30 of 760 m/sec is appropriate for the site allowing use of the maps is problematic.

More importantly, the characterization of the site as a thin soil site where there is 10 m of soil over firm (?) rock (Tetra Tech, 2010) indicates that a site response analysis is now required to address site effects on ground motions. The sharp Vs contrast between the lower velocity soil and the higher velocity rock will amplify short-period ground motions like PGA by as much as a factor of 2 for low rock ground motion inputs. The use of Vs30 in a site-specific hazard analysis will not capture these site amplification effects (Abrahamson, 2011). A site response analysis with a Vs profile into the rock should be performed. Using an equivalent-linear or fully non-linear computer code would be acceptable. It is recommended that direct measurements of Vs be made for input into the site response analysis.

3. **Explain why the calculated hazard for the background earthquake PGA of 0.24 g was estimated but ignored in the recommendation provided in Appendix E.**

   EFR did not respond to this statement. However that question is now irrelevant because of the following actions. As recommended and agreed to by Denison in Response 3, a site-specific PSHA is the best approach for quantifying the hazard at the site particularly from background earthquakes. Denison states that was done as in discussed in Response 5 and as contained in Attachment A. A site-specific PSHA was in fact not performed but the National Hazard Maps were used as stated above and below.

4. **Provide information to justify the use of 15 km distance for a background earthquake Mw 6.3 event.**

   EFR's response referred back to Response 3. EFR stated that the 15 km distance was selected because it would provide a conservative PGA at the site. This response fails to answer the question. A distance of 10 km would also provide a "conservative PGA at the site". However, this is now an irrelevant question because a deterministic seismic hazard analysis is to be replaced by a site-specific PSHA although such an analysis has yet to be performed.

5. **Perform and report results of a site-specific PSHA in lieu of using the USGS National Hazard Maps for developing site-specific seismic design parameters.**

   As commented above, a site-specific PSHA was not done and the 2008 USGS National Hazard Maps were used. The USGS National Hazard Maps consider the Colorado Plateau in which the site is located as part of the central and eastern U.S. with respect to ground motion prediction models. Denison's Attachment 5 shows those ground motion models. Recent research by the USGS (McNamara et al. 2012) and studies for the proposed Blue Castle nuclear power plant site near Green River (Jennie Watson, personal communication, Dec 2012) indicate that is an erroneous assumption and that the use of western U.S. ground motion prediction models is more appropriate. Early site-specific PSHAs including an analysis for the NRC-regulated Atlas Moab tailings site (Wong et al. 1996) and the U.S. Bureau of Reclamation's Glen Canyon Dam (URS 1999) used western U.S. ground motion models. This is another reason why the National Hazard Maps should not be used for developing site-specific design parameters. It is strongly recommended that the Next Generation of Attenuation (NGA) ground motion prediction models be used in the site-specific PSHA for White Mesa. It is expected that the USGS will use the NGA models for the Colorado Plateau in the 2013 National Hazard Maps.

6.0 Slope Stability

6.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 1; INT 06/1; Slope Stability

The interrogatory requested that EFR do the following:

1. Demonstrate slope stability for the tailings impoundment and new cover system using shear strength parameters and other soil properties assigned to the various components (cover, embankment/dike, tailings, and foundation) consistent with soil type, degree of compaction, and anticipated degree of variability. Justify selection of values for soil parameters.

2. In evaluating slope stability, address and report the effects of shallow and non-circular failure surfaces, in addition to circular and/or deeper ones.

3. Demonstrate that assumed drainage conditions are appropriate, are at least consistent with, or are conservative compared with drainage/seepage results, projected immediately at closure and at the end of the impoundment design life (i.e., 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years).

4. Assess the slope stability of Cell 1 adjacent to Cell 2 where mill debris and contaminated soils are to be placed and covered.

5. Explain and justify the selection of the pseudo-static coefficient used in the assessment of seismic stability. If the selected value of the pseudo-static coefficient cannot be justified,

revise the value of the coefficient used in stability analyses and revise and report the results of stability analyses.

6.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 1; INT 06/1; Slope Stability

IN ITS RESPONSE, EFR provided a revised slope stability analysis (Attachment D of the Response, to be included in the future Appendix E, Slope Stability Analysis, of the Updated Tailings Cover Design Report (Appendix D to the revised Reclamation Plan).

IN ITS RESPONSE, EFR also indicated the following:

- *The revised stability analyses include evaluation of shallow and non-circular failures;*
- *The phreatic conditions used for the revised stability analyses are consistent with regards to the tailings dewatering analyses;*
- *The revised stability analyses include evaluation of the stability of the Cell1 Disposal Area embankment; and*
- *An update to the previous seismic study for the site has been conducted and was included as Attachment A of the previous response submittal (Denison, 2012a). The pseudo-static coefficient is estimated as 0.10 corresponding to 2/3 of the Peak Ground Acceleration (PGA) presented in the Attachment A of Denison (2012a). This pseudostatic coefficient was used for the revised slope stability analyses.*

6.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 1; INT 06/1; Slope Stability

The Division finds that the revised slope stability analysis provided in the revised Attachment D to the EFR response did not adequately address several considerations and criteria that may be important to the analysis of the stability of the closed tailings embankment, including the following:

- **No details were provided regarding shear strength data for the liner and LCRS components in Cells 4A and 4B**
- **No information was provided as how the bottom liner component(s) was (were) simulated in the global stability analysis completed for cross Section A through Cell 4B**
- **No details were provided regarding shear strength data for the liner and LCRS components in Cell 2**

- **No information was provided as how the bottom liner component(s) was (were) simulated in the global stability analysis completed for cross Section B through Cells 2 and 1**

- **Insufficient information was provided regarding:**

  1) **the estimated in-place dry density, in-place most density, and in-place saturated density (unit weight values) of the tailings;**

  2) **rationale for selecting the tailings condition and tailings properties assumed in the analysis (e.g., drained vs. undrained conditions and for selection of in-place moist tailings density vs. in-place saturated tailings density for long-term static conditions or long-term seismic conditions); and**

  3) **the location of the assumed water table, e.g., if drained condition assumed;**

- **The discussion and Table E.1 in Attachment D of table of the material properties used in the model did not distinguish between different material strength parameters assumed for long-term static conditions vs. long-term seismic conditions, e.g., no discussion of percentage reduction in strength properties for the seismic (pseudostatic) stability analysis was provided;**

- **No discussion of or rationale was provided for whether it may be appropriate and reasonably conservative to assume that the tailings dewatering system might be clogged, possibly leading to ineffective drainage at the base of the tailings cell in area including the lowest point in the tailings bottom surface and therefore possibly result in an undrained condition within the tailings. For such a case, undrained tailings strength relationships might suggest strength values for the tailings that may be different than those assumed by EFR; and**

- **No discussion or rationale was provided for whether it may be appropriate and reasonably conservative to assume that the strength parameters for the clay liner in the Cell 1 area might be estimated based on the PI that would lead to the weakest strength, or estimated using some other method that would generate the weakest estimated shear strength value for the clay liner.**

The Division requests that EFR, in Attachment D, further define how the tailings total unit weight value stated in Table E.1 (90 pcf) and used in the revised slope stability analysis was derived (or how representative a value that value is of the tailings). For example, tailings sample results (see Appendix F, Settlement and Liquefaction Analyses of Updated Tailings Cover Design Report, Denison 2011) indicate that the tailings have an average specific gravity of 2.73; if a dry unit weight of 90 pcf were assumed (Section E.3 of Attachment D of this Response,) an average tailings void ratio of about 0.89 would result. Based on this void ratio, the tailings bulk density would be approximately 119.4 pcf, compared to the total

unit weight of the tailings listed in Table E.1 of Attachment D of this Response of 95 pcf. Alternatively, if an average tailings dry unit weight of 86.3 pcf were assumed (as was done in Appendix F, Settlement and Liquefaction Analyses of the Updated Tailings Cover Design Report, Denison 2011), then an average tailings void ratio of about 0.97 would result. Based on this void ratio, the tailings bulk density would be approximately 117.2 pcf. EFR should reevaluate and verify that their assumed tailings properties, calculation methodologies, and assumptions are representative, reasonably conservative, and bounding.

7.0 Settlement and Potential for Cover Slope Reversal and/or Cover Layer Cracking

7.1 Round 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 4; INT 07/1; Technical Analysis - Settlement and Potential for Cover Slope Reversal and/or Cover Layer Cracking

The interrogatory requested that EFR do the following:

Refer to Appendix D, Updated Tailings Cover Design Report of the Reclamation Plan, Rev. 5, and Drawings TRC-1 through TRC-8 in the Reclamation Plan, Rev. 5.0:

1. Please revise (i.e., steepen) the slopes of the top slope portions of the final cover system to provide an adequate factor of safety to ensure long-term stability of the covered embankment area considering:
    a. The potential for future slope reversal(s) and/or cracking to occur in the cover system due to long-term total and differential settlement or subsidence which could lead to conditions where ponding of precipitation could occur on the cover system in the future, after the end of the active institutional control period; and
    b. The significant disparity between the presently proposed topslope inclination ranges and published recommended ranges of slopes for final cover systems for uranium mill tailings repositories, surface impoundments, and landfills – namely ranging between 2% to 5% (e.g., see DOE 1989; EPA 1989; EPA 1991, and ITRC 2003 and EPA 2004).

    OR, alternatively, provide additional evaluations that clearly and unequivocally demonstrate (1) the ability to construct such gently sloped cover systems as proposed, designed, and specified and (2) the ability of the proposed embankment closure cover design to accommodate settlement-induced slope changes (including slope reversal) without increasing infiltration into the stabilized tailings impoundment.
2. Provide technical justification for 1) quantitative acceptance criteria to be used as the basis for evaluating the potential for slope reversal within the cover system in terms of potential long-term total and differential settlement, 2) quantitative assessments of maximum tensile strain capacity and other engineering properties such as Atterberg limits of the materials to be used in design of the cover system, and 3) quantitative acceptance criteria, including maximum allowable linear and angular distortion values, including effects of bending within

any select layer or layers of the cover, and (4) the minimum acceptable factor of safety for concluding that cover layer cracking will not occur.

3. Provide engineering analyses (including calculations and numerical modeling simulations as applicable) documenting the range of anticipated total and differential settlements within each of the containment cells. In doing so, use consolidation parameters obtained from site-specific testing of the tailings materials, reflecting both spatial and temporal variations in the tailings. Data from other sources may supplement (but not replace) site-specific test data in the analyses.
4. Demonstrate that tailings have been deposited in such a way that variations in tailings properties by location do not compromise the stability of the tailings as a foundation for cover system construction. Consider effects of sand-rich tailings zones lying adjacent to our near slime-rich tailings zones, due to deposition during slurry flow. Describe and account for effects of any different tailings placement methods (e.g., wet slurry vs. thickened slurry deposition) used throughout the mill's operating life. Identify and quantify the effects on stability of variations in such tailings physical characteristics as moisture content, consolidation coefficients, specific gravity, hydraulic conductivity (as listed in Appendix D Updated Tailings Cover Design Report, September 2011). Perform and provide results of numerical analyses using this information to project differential settlement across the tailings impoundments using software such as the Fast Lagrangian Analysis of Continuum (FLAC®) code (Itasca 2009) or other similar software, as appropriate. Alternatively, provide information to justify why such analyses are not warranted.
5. Include secondary settlement (i.e., creep) and any seismically induced settlement of the tailings in settlement analyses and consider their effects when assessing the anticipated performance of the cover system.
6. Demonstrate that the results of settlement analyses are consistent with results of drainage/dewatering analyses. Ensure that drainage/dewatering analyses reflect the tailings and drainage conditions (including slime drain system) existing in each cell.
7. Perform and report results of sensitivity and uncertainty analyses to demonstrate that the cover system will remain stable despite the effects of differential settlement. Report the time required to reach 90% consolidation.
8. As part of the analyses identified above, please also perform a seepage analyses to evaluate the shape of the phreatic surface within the tailings prism for each representative area within Cells 2 and/or 3, 4A, and 4B to be analyzed for consolidation timeframes and in differential settlement analyses. Ensure that effects of planned dewatering procedures and the dewatering system design configuration in each specific cell analyzed are reflected in seepage analyses.
9. Provide sensitivity analyses to assess the effect a of changes in tailings coefficients of consolidation parameters, void ratios, and tailings hydraulic conductivity values (note: it is acknowledged that values of all of these parameters are subject to uncertainty) on the amount of time required to reach approximately 90% consolidation of the tailings at each locations assessed within each cell and/or across individual tailings cells.

10. Using the information obtained from the analyses identified above, for each critical section defined, complete differential settlement analyses and compare the analyses results to the specified design criteria and evaluate the potential for slope reversal(s) to occur in the cover system over the tailings cells over the worst-case sections analyzed.
11. Provide information on the expected range of plasticity characteristics of the soil materials proposed for use for constructing the highly compacted upper portion of the radon attenuation and radon attenuation and grading layer of the proposed cover system, and specify design criteria (including maximum allowable values of both linear and angular distortion) to be used for evaluating the potential for cracking of this layer to occur as a result of any differential settlement that may occur.

7.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 4; INT 07/1; Technical Analysis - Settlement and Potential for Cover Slope Reversal and/or Cover Layer Cracking

IN ITS RESPONSE, EFR provided a list of eight reclaimed uranium mill tailings repositories in the U.S. where either cover slopes or portions of cover slopes have been constructed at inclinations of less than 1 %.

IN ITS RESPONSE, EFR also did the following:

1) *Conducted a revised settlement analysis to update the analysis that was completed for Rev. 5.0 of the Reclamation Plan in 2011 (Denison 2011)*

2) *Provided additional discussion of the results of that analysis (provided as part of this Response)*

3) *Conducted a cover cracking analysis for the highly compacted cover layer (provided as part of this Response).*

IN ITS RESPONSE, EFR further indicated the following:

- *No site-specific testing of tailings is proposed to be performed;*

- *Knowledge of tailings discharge history with observation of the response of tailings to interim cover placement (i.e. settlement monitoring) provide the most reliable information for identifying the potential for, and location of slimes or other soft zones. Interim cover has been placed over the tailings in Cell 2 and the portions of Cell 3. The results for Cell 2 are considered representative of the conditions that would be expected for Cell 3 and Cells 4A and 4B;*

- *The one-dimensional consolidation analyses are seen as providing a realistic estimate of total amount of primary consolidation settlement due to dewatering;*

- *Sufficient information was provided in the dewatering analyses to estimate the rate at which consolidation settlement will occur during dewatering. Supplemental seepage analyses were not performed for the settlement analyses. The actual rates and amounts of settlement occurring during the dewatering phase will continue to be monitored as dewatering progresses to provide verification of the estimated settlements at each monitoring location; and*

- *Sensitivity analyses to variations in the rate parameters (as reflected in settlement monitoring results) were performed for the 90 percent consolidation calculations and the range of values are provided in Response 2 for Cell 2. The results for Cell 2 are considered representative of the conditions that would be expected for Cell 3 and Cells 4A and 4B.*

7.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 4; INT 07/1; Technical Analysis - Settlement and Potential for Cover Slope Reversal and/or Cover Layer Cracking

As discussed in the Response to Interrogatory No. 3 in Section 3.0 above, EFR did not provide settlement performance data or settlement prediction analyses for any of the other facilities referenced by EFR as having been constructed with a similar range of topslope inclinations. Similarly, EFR did not provide any information demonstrating a correlation between observed settlement at these repositories and the future settlement predictions developed for those facilities that might allow the performance of these facilities to be evaluated with respect to their observed or predicted post-construction behavior.

The revised settlement analysis included one-dimensional analyses of both primary consolidation and estimates of settlement due to creep associated with secondary consolidation occurring during (i) interim soil cover placement/loading; (ii) tailings dewatering; and (iii) final cover loading. EFR also provided estimates of seismically-induced settlement due to earthquake loading.

In its settlement analyses, EFR relies of data from settlement monuments in Cell 2 to estimate settlement parameters (e.g., compression indices and coefficients of consolidation) for the tailings. Each monument or monitoring point is treated independently, and the range of data and corresponding analytical results are reported in terms of maximum, minimum and average values. Examination of the data indicates that the 5 westernmost monuments or monitoring locations (2W12W2, 2W3, 2W3-S, and 2W4) behave very differently than the others, with an average observed settlement of about 0.77 feet from July 1991 (on average) to the start of dewatering in 2009, whereas the other data set only averages about 0.1 feet during a period most typically from July 2005 to January 2009. Given the grossly different amounts of settlement between the two sets of settlement data

(and the issue not simply being a matter of greater tailings thickness), the use of a simple average across the two sets of data seems inappropriate. More importantly, given the relatively short time of settlement observation for the eastern monuments and the flat shape of the settlement curves, it seems likely that significant settlement occurred prior to monitoring, thus making this approach to settlement estimation problematic as was discussed in the first Interrogatory. If significant portions of the settlement time histories were not captured in the eastern monitoring data, the use of "average" values derived from the data (as apparently is the case currently) will not represent the behavior a majority of tailings under newly added load. On the other hand, if the range of settlement data as measured is representative of true settlement behavior, then a significant range of possible behavior should be expected (reflective of directive in the first round of interrogatories to consider a range of tailings ranging from fine grained slimes to coarse sands and their spatial distribution within the impoundment cells).

EFR has attempted estimate both compression indices and coefficients of consolidation for the tailing by curve fitting settlement data from five of the monitoring points (those possessing enough curvature to which a curve can be fit) with theoretical settlement curves. From the plots provided in Attachment E, it appears that something is amiss in the curve-fitting analyses since primary and secondary consolidation appears to be happening at the same time, rather than secondary occurring after completion of primary. Such an error would make the "back-calculated" indices and coefficients incorrect. This issue should be examined further. Again, as stated in the first round of Interrogatories, this back-calculation or curve-fitting approach is problematic at since the start of the settlement time history prior to monitoring is missing and a third variable (the effective drainage length) is not precisely known. Because of this, variance from calculated values should be expected and must be considered when evaluating subsequent cover performance. To better address the shortcomings inherent in using this curve-fitting/back-calculation approach, it was stated in the previous Interrogatory to "use consolidation parameters obtained from site-specific testing of the tailings materials, reflecting both spatial and temporal variations in the tailings."

The settlement analyses performed by EFR focused on evaluating settlement in the Cell 2 area only. No discussion or analyses were provided regarding any tailings management/disposal process-related differences such as different tailings placement methods/modes that may have occurred/might exist with regard to the various tailings disposal cells or of the effects that such differences might have on tailings consolidation and settlement behavior in each disposal cell area. Additionally, no discussion or analyses were provided for differences in dewatering system designs, differences in the expected dewatering efficiencies likely to occur between different cells (with resulting differences in statured tailings thicknesses at the different stages in time evaluated in the settlement analyses), or differences in thicknesses of tailings in the different cells (e.g., tailings thickness in Cell 4A varies from about 26 to 42 ft, with an average thickness of about 34 ft, vs. tailings thickness ranging from about 14.5 ft to 28.50 ft in Cell 2).

In the Response to Item 2. of this Rd 1 interrogatory, EFR indicated that a final water level in the tailings in Cell 2 at the end of dewatering was estimated based on dewatering

analyses presented in the Revised ICTM Report. However, the Reclamation does not contain a schedule for, a detailed description of, measures that EFR will undertake to ensure that dewatering of Cells 2 and 3 will be completed within the 7-year time period specified in the latest Financial Surety submitted to the Division by EFR, or a shorter time period. This is important since recent data suggests that the current rate of dewatering in Cell 2 may be on the order of 1 inch per year. As part of the additional settlement analyses that are needed to further address differential settlement and evaluate impacts of differential settlement on cover slope integrity/slope reversal, EFR needs to address additional requirements related to dewatering analyses, measures, costs, and schedule for dewatering of Cells 2 and 3 as described in Section 15.3 below.

In calculating the settlement of the tailings in Cell 2, it appears that tailings above elevation 5604.95 (a datum which seems to correspond to the average 2009 first quarter water levels plus an assumed 3-foot perched zone thickness) have been omitted from consideration during future dewatering and placement of the final cover (from time t1 to t2, and from t2 to t3). Even above the water table, these materials will respond to the added stresses from cover construction and their contribution to total settlement should be included.

Neither the response nor Attachment E presents a rationale for selecting tailings properties (e.g., specific gravity of tailings of 2.75, moist unit weight of 100.29 pcf above the capillary fringe, long-term moisture content of 16.2%, void ratio of 0.99 assumed for the Phase 1 analysis) to be used in the revised settlement analyses. Further, while unit weights for the various components of the cover system have been provided, their thickness have not all be provided, thus preventing a check of the stresses resulting from cover placement. The thickness of each component of the cover system needs to be indicated in the calculation spreadsheet.

Without a narrative and sample calculations for all of the spreadsheet results presented in Attachment E, it is difficult to assess the adequacy of the analysis presented. For example, it is unclear how the bottom elevation of the "upper zone" was determined, and then how the thicknesses of the upper and lower zones correspond to the drainage path used to determine the time for 90% consolidation. Such clarification need to be provided in order to assess the adequacy of the settlement calculations. General references to calculation methodology such as "Terzaghi et al. 1996, pages 223-240" are too general to satisfy this need for additional information.

It is unclear what time for primary consolidation was used in calculating the secondary settlement, and the reviewer is otherwise unable to assess the results calculated by EFR. Again, a narrative and/or sample calculations (or at least illustrative equations and a description of how specific values were determined) should be provided for all spreadsheet calculations in order to assess their correctness.

With respect to the calculated seismically induced settlement, there appears to be errors in the calculation process (for example, the vertical strain should be twice the resultant of the vertical strain for 15 cycles of shaking multiplied by the variable Cn [doubling is to account for the multi-directional application of strain as described in the referenced Stewart and Whang (2003) paper]). Also, the calculations incorrectly treat the tailings as a single layer

subject to a constant amount of cyclic strain. The tailings should be discretized into smaller, discrete layers and the stress and strain calculations redone. Another apparent inaccuracy in EFR's calculation is an apparent capping of shear strain amplitude to 1.0%. In Stewart and Whang's cyclic strain charts (Fig 3 in their paper), cyclic shear strain values are shown up to 1%, which is a reasonable limit for compacted soils (noting that "compacted soils" is part of the title of Stewart and Whang's paper). However, the soils in question are uncompacted tailings in which cyclic strains could exceed 1%. Hence, extrapolation or another calculation methodology should be used to determine seismically induced settlement. Also, the Stewart and Whang procedure is not well established (vetted) within the geotechnical earthquake engineering community. Consequently, EFR should compare the results obtained using this procedure with those of a more-well established procedure such as Tokimatsu and Seed (1987) or Ishihara and Yoshimine (1992).

In reviewing Table 2 'Summary of Settlement Results', it is unclear how the values shown for "Total Settlement five years after placement of Final Cover due to Final Cover Placement, Creep, and a Seismic Event" in row 5 (minimum and maximum values of 0.52 to 0.83) were determined. While calculations supporting the preceding four rows of settlement results in the table are readily identified within the spreadsheet calculations presented in Attachment E, no explicit calculations justifying the fifth row of values are presented. Additional information is needed.

In its assessment of differential settlement and cover cracking analysis, ERF estimates that the "maximum potential differential settlement that could be expected between adjacent movement monitoring locations would be on the order of 0.3 feet." With typical spacings between monitoring locations of about 250 feet (scaled from the figure by the reviewer, and an explicit statement of such should be provided by EFR), this equates to an average deflection ratio (differential settlement) of about 0.12%, which is less than the proposed minimum cover slope of 0.5%, and hence on this basis, ponding is not expected. However, the value of 0.3 feet needs to be reassessed due to the issues just previously presented.

In assessing the potential cracking of the cover, EFR has relied upon the most critical combination of projected settlement of a monitoring point (0.9 ft at 2W4-S) and it associated distance away from the edge of the tailings cell (being for this monument 100 ft) to determine the greatest strain demand on the cover based on the approach of Lee and Shen (1969). This value is then compared to the cracking resistance based on an empirical relationship using soil index properties (Claire et al. of Morrison-Knudsen, 1993). While this approach is reasonable, the input for Lee and Shen's horizontal movement formula has been incorrectly selected. In the analysis, EFR has used the average slope of the settlement profile (0.9/100) rather than a local maximum which would include the effects of bending. This point is illustrated in the test data and illustrative example provided in Lee and Shen's paper: the vertical displacement between the two ends of their 93-inch long soil beam is 1 inch, yielding an average slope of about 1%; however, the maximum slope in their beam which includes bending is 2%, located near the middle of the beam. In Lee and Shen's paper, the maximum reported tensile horizontal strain is about 0.6%, derived from the 2% maximum (not 1% average overall) slope. To be consistent with Lee and Shen, EFR should use the expected peak slope between points, not the average between the two points.

Assuming that the peak is twice the average as in Lee and Shen's test case (although ERF will need to provide a reasoned and defensible value specific to this project; representative published relationships depicting cover deformation shapes and tensile strain/distortion relationships include those included in Gourc et al. (2010) and Rajesh and Viswanadham (2010), the maximum horizontal strain appears to be twice that of the 0.028% previously reported, exeeeding the reported maximum allowable strain of 0.05%, meaning that the layer is expected crack. The analysis must be redone to include the effects of localized bending as was indicated in the first round of Interrogatories, and the performance of the cover reassessed accordingly.

Also relating to the cracking analysis, a thickness of 4.7 ft is used for the soil layer. However, the actual thickness of the sandy clayey silt soils in the tailings cover design, which collectively serve for radon attenuation is 8.8 ft per Figure 2-2 of the Revised ICTM Report (Denison Mines 2010). The analysis should either be revised to reflect this value or a justification provided for the value used.

As part of the previous Interrogatory, EFR was asked to "demonstrate that the results of settlement analyses are consistent with results of drainage/dewatering analyses, and ensure that drainage/dewatering analyses reflect the tailings and drainage conditions (including slime drain system) existing in each cell. In EFR's Response, the following statement is made:

"It should be noted the assumptions made in the one-dimensional consolidation analyses of Phase 2 (i.e. complete coverage of the tailings impoundment by an infinitely-permeable underdrain system, and instantaneous drawdown to final water level) do not exist within the impoundment, and will result in an underestimation of the time required to achieve 90% consolidation. The results of the tailings dewatering analysis, which includes the 3-dimensional aspects of flow toward the underdrain strips, and a finite underdrain permeability, are considered to provide a more reliable estimate of the duration Phase 2 consolidation."

Unfortunately, no further reference or discussion is presented regarding the dewatering analyses, and hence the question of time needed to reach 90% consolidation remains unresolved. Based on its consolidation settlement analysis, EFR reports that the time to reach 90 percent of primary consolidation due to dewatering of the tailings in Cell 2 ranges from 0.14 to 0.63 years. However, in the dewatering analysis (see Appendix J of Revised Infiltration and Contaminant Transport Modeling Report, White Mesa Mill Site, Blanding, Utah, by MWA 2010)), EFR reports that "the MODFLOW dewatering model predicts that the tailings would drain down nonlinearly through time reaching an average saturated thickness of 3.5 feet (1.07 m) after 10 years of dewatering." These two conclusions are not compatible. As part of this Response to Interrogatory, the results of the dewatering analyses need to be considered in conjunction with the settlement analyses and the subsequent assessment of cover settlement.

As stated previously, no explicit discussion or analyses were provided regarding any tailings management/disposal process-related differences such as different tailings placement methods/modes that may have occurred/might exist with regard to the various

tailings disposal cells or of the effects that such differences might have on tailings consolidation and settlement behavior in each disposal cell area. Additionally, no discussion or analyses were provided for differences in dewatering system designs, differences in the expected dewatering efficiencies likely to occur between different cells (with resulting differences in statured tailings thicknesses at the different stages in time evaluated in the settlement analyses), or differences in thicknesses of tailings in the different cells.

In summary, based on review of all of the above, the Division concludes that the analyses provided by EFR are, in general, overly simplistic and do not adequately account for the full range of different conditions that may occur with the tailings management cells area. Extrapolating assumed tailings parameters and properties from published data on tailings at other facilities creates additional uncertainties in the consolidation, settlement, stability, and liquefaction analyses. Assumed data must be supplemented by site-specific data; alternatively, the most reasonably conservative values might be used if adequate assessment and justification is provided. Justifications for some parameter values are lacking in EFR's response. EFR should provide additional analyses that specifically address the different factors and conditions and their effects referenced in the preceding paragraphs. Also, there appears to be several errors, omissions, discrepancies, and insufficient information in the analyses conducted and provided by EFR which need to be to be addressed before appropriate and reliable conclusions can be reached.

8.0 Erosion Stability Evaluation

8.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 4; INT 08/1; Technical Analysis - Erosion Stability Evaluation

The interrogatory requested that EFR do the following:

Refer to Section 3.3.5 of the Reclamation Plan, Rev. 5.0 and Section 4.9 and Appendix G to Appendix D (Updated Tailings Cover Design Report), and Drawings TRC-1 through TRC-8 to the Reclamation Plan, Rev. 5.0: Please provide the following:

1. To further confirm the appropriateness and currency of the calculated Probable Maximum Precipitation (PMP) value and as used, for example, in the ET cover design erosion protection rock rip rap sizing calculations, please provide a revised PMP calculation updating the PMP distribution that incorporates information from the following documents, in addition to HMR 49 (Hansen et al.1984):
    - "2002 Update for Probable Maximum Precipitation, Utah 72 Hour Estimates to 5,000 sq. mi". – March 2003 Jensen 2003); and
    - "Probable Maximum Precipitation Estimates for Short Duration, Small Area Storms in Utah" – October 1995 (Jensen 1995)
2. Using the revised PMP information obtained from Item 1 above, provide revised calculations of required rock rip rap sizes for the cover sideslope areas using the updated method developed for round-shaped rip rap as described in Abt et al. 2008. Update and

revise other erosion protection calculation presented in Appendix G, as required and appropriate, to reflect the revised PMP determination.

3. Please provide additional calculations to estimate the magnitude and location of a potential gully intrusion into each soil-covered portion of the proposed cover system (e.g., using the procedure described in Thornton and Abt 2008). Demonstrate that excluding rock (gravel) particles from the currently proposed flattest (0.1 % and 0.5%) top slope areas would adequately protect against sheet flow under potential precipitation conditions and would adequately control longer-term rill and/or gully initiation and development. Provide information on required "overdesign" of the cover thickness needed to accommodate maximum predicted gully depths and locations.

4. Provide additional detailed cross sections showing every interface that will occur between sideslope cover layers and topslope cover layers. Demonstrate that all applicable filter criteria will be met for each interface between each topslope cover layer component and the proposed granular filter layer on the sideslope, including standard filter gradation criteria as well as applicable permeability filter criteria (e.g., for filter layer underlying riprap on sideslope areas). Consider filter criteria for preventing migration of granular materials into an adjacent coarser grained granular layer (e.g., Nelson et al. 1986, Equation 4.35); for preventing piping of finer grained cohesionless soil particles into an adjacent coarser-grained material layer (e.g., Cedegren 1989, Equation 5.3); and for preventing erosion of a finer-grained material layer from occurring over the long term as a result of flows in an adjacent coarser (filter zone) layer (e.g., Nelson et al. 1986, Equation 4.36). Include consideration of different specific filter stability criteria (e.g., NRCS 1994, Tables 26-1 and 26-2) for determining the maximum allowable D15 of a granular filter layer material for preventing erosion of any adjacent layer (e.g., sacrificial soil layer) consisting of fine-grained/finer-grained particles, as a function of soil type. Address applicable filter permeability criteria for the filter layer in the sideslope cover system, including Table 26-3 of NRCS 1994.

5. Provide revised cover system cross sections to include a thicker riprap layer on the cover sideslope areas (i.e., minimum thickness of 1.5 times the D_{50} of the rock rip size of 7.4 inches, or the D_{100} of the rock rip rap materials, whichever is greater) to bring the cover design into compliance with recommendations contained in Section 2.1.2 of NUREG-1623 (NRC 2002).

6. Provide revised construction drawings for the final cover that preclude the presence of low areas that have the potential for experiencing future concentrated flows (e.g., portion of cover overlying Cell 2 as depicted on Section B-3 on Drawing TRC-7) and that avoid areas having abrupt changes in slope gradient across the cells, (e.g., areas of cover having proposed 5h:1v slopes shown on Sections B-3 and C-3 on Drawings TRC-6 and TRC-7 and Detail 7/8 on Drawing TRC-8, etc..) to be consistent with UAC R313-24-4 10CFR40, Appendix A, Criterion 4.

8.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 4; INT 08/1; Technical Analysis – Erosion Stability Analysis

IN ITS RESPONSE, EFR provided, as requested, revised PMP calculations using the methods described by Jensen 1995 and Jensen 2003.

IN ITS RESPONSE, EFR indicated that the Thornton and Abt 2008 procedure is applicable to soil-covered slopes but is not applicable to the flatter topslope areas only, where the Temple et al. 1987 method was instead used to evaluate long-term erosional stability.

IN ITS RESPONSE, EFR also revised the previously proposed embankment erosion protection design to include use of angular, rather than rounded riprap, on the southern and eastern slopes of Cells 4A and 4B and provided revised erosional stability analyses (included in Attachment C, which will be incorporated as a revised Appendix G in the next version of the Updated Tailings Cover Design Report [Appendix D of the Reclamation Plan]) for that angular riprap. This resulted in a change in the riprap sizing on the embankment slopes for all areas experiencing non-accumulating flows.

IN ITS RESPONSE, EFR provided revised calculations to demonstrate that applicable filter gradation criteria for the various interfaces in the cover system layer components will be achieved. The calculations used updated results of laboratory tests conducted on additional samples of cover borrow materials collected in April 2012. Filter gradation criteria of NRCS 1994, Nelson et al. 1986, and Cedegren 1989 were evaluated.

IN ITS RESPONSE, EFR indicated that the Construction Drawings will be revised to show the filter and rock riprap layers.

The interrogatory requested that EFR address the minimum required thickness of the riprap layer on the cover system and the inclinations needed in certain areas of the cover to minimize potential flow concentration and avoid abrupt sloe changes.

IN ITS RESPONSE, EFR indicated that the revised Drawings will show a minimum thickness of 1.5 times the D_{50} of the rock riprap size, or the D_{100} (whichever is greater) and that Section B-3 on Drawing TRC-7 will be revised to show the correct direction of the 0.5 percent slope to be toward the south to match the plan view shown on Drawing TRC-3. The 5H:1V slopes shown on the cover topslope will be revised to be 10H:1V. The drawing updates will be included in the next revision of the Reclamation Plan after approval of the final cover design.

8.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 4; INT 08/1: Technical Analysis – Erosion Stability Analysis

The revised calculated 1-hr and 6-hr duration PMP values are equal to or smaller in magnitude than the respective PMP values previously determined (8.3 inches and 10.0 inches, respectively) using the method of Hansen et al. 1984. The existing design is, thus, oversized relative to precipitation projected to occur at the site. Therefore, the previous analyses are considered acceptable and bounding.

Review of the topslope erosional stability calculations indicates that these analyses are not complete and that the validity of certain assumptions used in these calculations has not been adequately demonstrated. Missing from these analyses, for example, are a sensitivity analysis case of bare soil conditions occurring on soil-only topslope surfaces (e.g., "uniform weathered earth" or bare soil condition) to simulate a lack of vegetation on these topslope areas, and a full analysis and justification for the estimated Manning's "n" values appropriate for the soil-only surfaces, and gravel/soil admixture surfaces. For example, the response did not distinguish between an appropriate "n" value for uniform weathered earth conditions and "n" values for vegetated conditions; e.g., $n = (n_R^2 + n_S^2 + n_\Psi^2 - [0.0156])^{1/2}$ (Temple et al. 1987, p. 5).

Additionally, in the erosion analyses, EFR assumed a default flow concentration factor of 3, in accordance with recommendations in NUREG-1623 (NRC 2002). However, this assumption is valid only if uniform grading will be done during construction and differential settlement has been shown to be insignificant. As discussed in Section 3.3 above regarding the Response to Rd 1 Interrogatory 03/1 and in Section 7.0 regarding the Response to Rd 1 Interrogatory 07/1, neither the ability to construct the proposed flat topslope areas to a uniform slope nor the potential for differential settlement to occur in the tailings management area embankment after closure have been adequately demonstrated.

The EFR response and calculations and methodologies relating to sizing of angular and rounded riprap on the different sideslopes of the tailings cells area are considered acceptable.

The EFR response, calculations, and methodologies relating to evaluation of the filter gradation criteria are considered acceptable.

EFR committed to, but did not provide revised Drawings, revised CQA/CQC Plan, and revised Technical Specifications showing the filter and rock riprap layers. These revised documents will need to be reviewed, when available, to verify that these changes have been made. Because these revised documents were not submitted in its interrogatory response, this interrogatory will remain open.

EFR committed to, but did not provide revised Drawings showing the changes indicated for the rock riprap layer minimum thickness and cross sections . The revised drawings will need to be reviewed, when available, to verify that these changes have been made. Because

these revised documents were not submitted in its interrogatory response, this interrogatory will remain open.

9.0 Liquefaction

9.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 1; INT 09/1; Liquefaction

The interrogatory requested that EFR do the following:

Refer to Section 4.8 and Appendices C and F to the Appendix D, Updated Tailings Cover Design Report of the Reclamation Plan, Rev. 5:

1. Provide revised liquefaction analyses that rely upon actual site-specific data for the tailings materials, rather than assumed parameters. In doing so, revise the Reclamation Plan to correctly and defensibly characterize tailings properties consistent with these revisions throughout the document.

2. Correct apparent errors and conduct revised analyses using parameter values that are based on site-specific data. Correct discrepancies between calculated results and summarized, reported results.

3. Demonstrate that conditions assumed for liquefaction analyses are consistent with or conservative compared to results of tailings dewatering analyses. If this is not true, revise liquefaction analyses to be consistent with or conservative compared to results of tailings dewatering analyses, report results, and demonstrate that impoundments will remain stable with regard to liquefaction.

9.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 1; INT 09/1; Liquefaction

IN ITS RESPONSE, EFR indicated that the liquefaction analyses were revised to be applicable for long-term steady-state pore pressure conditions within the tailings, and are consistent with regards to the tailings dewatering analyses. The revised analyses also incorporate the update to the previous seismic study (provided as Attachment A to the May 31, 2012 response document). The weight of the cover system has also been included in the analyses.

EFR stated that a constant Standard Penetration Test (SPT) blow count (n-value) of 2 blows in 12 inches (uncorrected) was assumed for the tailings zones that will remain saturated under long-term steady state conditions. EFR indicated that an uncorrected n-value of 2 is considered to be a reasonable "lower-bound" estimate of the uncorrected blow counts for saturated tailings based upon a comparison with similar uranium tailings at other sites, and is a more conservative assumption than was used in previous analyses. Previous analyses assumed a constant n-value of 4 to represent the in-situ state of the tailings.

EFR stated that unsaturated tailings zones are not be susceptible to liquefaction and were not included in the analyses. The long-term dry density of the tailings was revised to be 90 pcf to be consistent with the value used for the updated radon emanation analyses. The revised liquefaction analyses are provided as Attachment F and summarized in the Table 1 below.

The computed factors of safety against liquefaction range from 1.76 to 2.28. Based on these results, EFR concluded that the tailings are judged not considered to be susceptible to earthquake-induced liquefaction during the design seismic event.

Table 1. Summary of Liquefaction Results

Depth from Top of Cover (ft)	*Saturated Thickness (ft)*	*CSR*	*CRR $_{7,5}$*	*MSF*	*Factor of Safety*
Cell 2					
31.7	*0*	*0.113*	*0.096*	*1.77*	*1.90*
34.7	*3*	*0.109*	*0.096*	*1.77*	*1.83*
37.7	*6*	*0.104*	*0.095*	*1.77*	*1.79*
40.7	*9*	*0.099*	*0.095*	*1.77*	*1.77*
43.7	*12*	*0.095*	*0.095*	*1.77*	*1.76*
Cell 3					
37.0	*0*	*0.085*	*0.095*	*1.77*	*1.97*
40.0	*3*	*0.087*	*0.095*	*1.77*	*1.93*
43.0	*6*	*0.088*	*0.095*	*1.77*	*1.91*
46.0	*9*	*0.088*	*0.094*	*1.77*	*1.90*
49.0	*12*	*0.087*	*0.094*	*1.77*	*1.91*
Cells 4A/4B					
12.0	*0.33*	*0.097*	*0.099*	*1.77*	*1.82*
15.0	*0.33*	*0.096*	*0.099*	*1.77*	*1.82*
18.0	*0.33*	*0.095*	*0.098*	*1.77*	*1.83*
21.0	*0.33*	*0.094*	*0.097*	*1.77*	*1.83*
24.0	*0.33*	*0.093*	*0.097*	*1.77*	*1.84*
27.0	*0.33*	*0.092*	*0.096*	*1.77*	*1.86*
30.0	*0.33*	*0.090*	*0.096*	*1.77*	*1.88*
33.0	*0.33*	*0.089*	*0.095*	*1.77*	*1.90*
36.0	*0.33*	*0.087*	*0.095*	*1.77*	*1.94*
39.0	*0.33*	*0.084*	*0.095*	*1.77*	*1.99*
42.0	*0.33*	*0.082*	*0.094*	*1.77*	*2.05*
45 0	*0.33*	*0.079*	*0.094*	*1.77*	*2.12*
48.0	*0.33*	*0.076*	*0.094*	*1.77*	*2.19*
51.0	*0.33*	*0.073*	*0 094*	*1.77*	*2.28*

IN ITS RESPONSE, EFR also indicated that the revised liquefaction analyses are consistent with regards to the tailings dewatering analyses.

9.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 1; INT 09/1; Liquefaction

In the Rd 1 interrogatory, EFR was requested to "provide revised liquefaction analyses that rely upon actual site-specific data for the tailings materials, rather than assumed parameters." EFR's response to this Interrogatory states that "a constant Standard Penetration Test (SPT) blow count (n-value) of 2 blows in 12 inches (uncorrected) is assumed for the tailings zones that will remain saturated under long-term steady state conditions." While this assumption of 2 blows in 12 inches (uncorrected) is a conservative reinterpretation of the previously assumed value of 4 blows in 12 inches, it is still only an assumption; it is not based on data. It is again requested that site-specific data for the materials be used in analyses, not assumed data. Alternatively, EFR should use, and provide adequate justification for demonstrating that the most reasonably conservative parameter values possible (are used) in all calculations.

The assumed SPT blowcounts are subsequently corrected using a fines content of 30, said to be based on an average of laboratory test values. Sands with this large of fines content are typically quite resistant to liquefaction (hence the much greater blow counts after the fines correction). Since the fines content value used to characterize the tailings is based on an average value (and given that the effect of fines content on liquefaction resistance is not linear), it is more appropriate to use a lower bound estimate of fines content rather than average value; otherwise, a false factor of safety may result for some of the coarser-grained materials. Again, as stated in the previous interrogatory, consideration should be given to the potential variation of properties of the tailings.

The liquefaction analyses presented in Attachment F use a peak ground acceleration of 0.15 g and a moment magnitude of 6.0. These values are consistent with those of revised probabilistic seismic hazard analyses. However, as part of the earlier deterministic analysis, Tetra Tech (2010) estimated a magnitude 6.3 for a random background event, said to be consistent with that used in previous seismic evaluations performed for sites in the Colorado plateau. Please clearly identify and justify the more appropriate value to use in the analyses, and revise analyses as needed.

The liquefaction analyses presented in Attachment F uses a dry unit weight of tailings of 90 pcf. Page C-4 of the REC plan (Denison Mines 2011) indicates that the dry unit weight of the tailings is 91.4 pcf, rather than 90 pcf. The dry unit weight of tailings used in the settlement analyses in Attachment E appears be 86.3 pcf. In the previous Interrogatory, it was stated that "consistent characterization of the tailings throughout the report seems to be needed." This issue remains unaddressed.

In the simplified liquefaction analysis procedure, the parameter K_σ which accounts for effects of confining stress is not used. At the base of the tailings, the currently computed effective vertical overburden stress is nearly two tons per square foot. At this value, Figure

14 of Youd et al. (2001) shows the value of K_σ for sands to be about 0.81, which would tend to reduce the as-calculated factor of safety. The factors of safety should be recalculated including the correction factor K_σ, or alternatively exclusion of this factor from analysis should be justified.

In the liquefaction analysis presented in the revised Attachment F, there appears to be multiple inconsistencies regarding the thicknesses of the various components of the cover system for each of the cells (and hence the stresses used in the analysis may be incorrect). Normal stresses calculated in the liquefaction analysis sheet are associated with assumed cover-system soil thicknesses, which appear in some instances to be too high, as well as with assumed relative compactions, some of which are too high. For example, the thickness of random fill material at 95% of Standard Proctor dry density in the cover is stated in the liquefaction analysis to be 4.7 feet for Cell 2. This appears to be too thick. Therefore, the results of the liquefaction analysis itself, which depend on the "compacted cover" thickness, apparently are in error. The entire design cover system in the liquefaction analysis, from top to bottom, is claimed in the liquefaction sheet to be as follows:

Topsoil rock mulch: 0.5 feet thick.

Random fill at 85% of Standard Proctor dry density: 3.5 feet

Random fill at 95% of Standard Proctor dry density: 4.7 feet

Grading fill at 80% of Standard Proctor dry density: 2.5 feet

The assertion that the value of 4.7 feet appears to be too high for the random fill at 95% of Standard Proctor dry density can be demonstrated from a number of sources. Figure 2.2 in the Revised ICTM Report (Denison Mines 2010) provides a "generalized" cross-sectional view of the cover system for the site and gives the purported general cover design is as follows:

Topsoil rock mulch: 0.5 feet thick.

Random fill at 85% of Standard Proctor dry density: 3.5 feet

Random fill at 95% of Standard Proctor dry density: 2.8 feet

Grading fill at 80% of Standard Proctor dry density: 2.5 feet

The random fill at 95% of Standard Proctor dry density has a thickness listed above of only 2.8 feet, not 4.7 feet. The REC plan (Denison Mines 2011) offers similar information, but with the thickness of random fill at 95% of Standard Proctor dry density being said to be only 2.5 feet. However, this generalized cross-sectional view of the cover system also is considerably different compared to plans for actual constructed thicknesses in Cells 2 and 3. To obtain a more accurate value for planned thickness of random fill at 95% of Standard Proctor dry density, it is necessary to turn to the engineering drawings. A check can be made of the value used in the liquefaction analysis by comparing it against "compacted cover" values shown for Cell 2 in Sheet TRC-7 of the REC Plan, Revision 5.0 (Denison Mines 2011). Sheet TRC-7 is titled, "Cover over Cell 2 Cross Sections." These cross sections of the planned Cell 2 cover system show a maximum thickness for the "compacted cover", representing the random fill at 95% of Standard Proctor dry density,

of about two feet. However, that exists only in a few places. Cross Section A shows only about 40% of the cell along that cross-sectional line having any "compacted cover" whatsoever, with an average thickness of only about one foot where that "compacted cover" does exist. About 60% of the cell along Cross Section A has no cover of 95% of Standard Proctor dry density at all.

Cross Section B shows only about 25% of the cell along that cross-sectional line having any "compacted cover" of 95% of Standard Proctor dry density whatsoever, with an average thickness of about one foot where the compacted soil does exist. 75% of the cell along that cross section has no "compacted cover" of 95% of Standard Proctor dry density at all. Cross Section C shows only about 25% of the cell along that cross-sectional line having any "compacted cover" of 95% of Standard Proctor dry density whatsoever, with an average thickness of one foot or less where the "compacted cover" exists. Sheet TRC-2 also confirms this, but in plan view. Cross Section C shows about 75% of the cell along that cross-sectional line with no cover having 95% of Standard Proctor dry density at all.

Assuming that the cross-sections provide a representative cross-sectional view of the cover system in Cell 2, it appears that, on average, to a rough approximation (assuming that each cross-section represents one-third of the cover), coverage of the cell by any 95%-of-Standard-Proctor "compacted cover" at all exists on only a little more than [(0.333)(0.40) + (0.333)(0.25) + (0.333)(0.25)] = 0.3, or three-tenths (3/10), of the cell. The average thickness of "compacted cover" at the cell, averaged over the cell's entire area, is thus only about (0.3)(1 ft) = 0.3 ft.

The liquefaction analysis sheet uses a value for the thickness of "compacted cover" having 95% of Standard Proctor dry density that happens to be [(4.7 – 0.3)/0.3] x 100% = 1470% in excess of the actual value. In other words, the thickness of the random fill at 95% of Standard Proctor dry density assumed in liquefaction analysis is 15.7 times that value. Please address these inconsistencies in the liquefaction analysis spreadsheet calculations and provide correct values for the thickness of the random fill at 95% of Standard Proctor dry density.

Apart from issues associated with characterization of the cover system components, the liquefaction analysis spreadsheet calculations presented in Attachment F indicated a tailings surface elevation for Cell 2 of 5613.5 feet. 5613.5 feet is the approximate surface elevation for much of the tailings in Cell 2. However, tailings in the vicinity of Cross Section C in Cell 2 have much higher elevations in the northern half of the cell. There, the elevations reach to 5623 feet. Also, the liquefaction analysis spreadsheet calculation shows that the water surface elevation for Cell 2 is 5593.03 ft amsl. For of the second quarter of 2012, on May 29th, the reported depth to water in the tailings slimes in Cell 2 was measured as 21.10 ft (EFR 2012). The top of slimes drain pipe is at an elevation of 5618.73 ft amsl (personal communication with Russ Topham of the Division on October 5, 2012, who reported receiving it from Garrin Palmer of EFR on October 5, 2012). So, the calculated head of water in the tailings is estimated to be 5618.73 ft amsl minus 21.10 ft, or 5597.63 ft amsl. This is 4.6 feet higher than what is shown in the liquefaction analysis sheet. These values should be corrected.

As is the case for Cell 2, so it is for Cell 3 that actual planned thicknesses of various layers at different percentages of Standard Proctor dry densities, or at different compactions, greatly vary from what the liquefaction sheet shows. Sheet TRC-6 in the REC Plan (Denison Mines 2011) demonstrates this. Please fix the stated thickness values. Also, since the errors in thicknesses translate to errors in calculated normal stresses induced by cover systems in the various cells, and other calculations on the liquefaction analysis sheet, please be sure that these are fixed as well.

The liquefaction analysis spreadsheet calculations identify the tailings thickness for Cell 2 as 32.5 feet, that for Cell 3 as 38.5 feet, and that for Cells 4A/B as 40.5 feet. Table F.1 of Denison Mines 2011 is cited. Table F.1 and the Attachment F-2, Settlement Analysis spreadsheets in Denison Mines 2011 likewise provide figures of 32.5, 38.5 and 40.5 feet for the tailings thicknesses for Cells 2, 3, and 4A/B, respectively. These figures, however, appear to conflict with the tailings thickness for Cells 2 and 3 given on Page C-2 of the Response text of "approximately 30 feet" and "the tailings thickness for Cells 4A/B of approximately 42 feet" (Denison Mines, 2011). These inconsistencies should be fixed.

It can be seen, based on 1980 as-built drawing information from Energy Fuels Nuclear, Inc., as shown on Sheet TRC-7 of Denison Mines (2011) that, for most of the Cell 2, the elevation of the tailings surface is 5613 ft amsl. This knowledge, coupled with some additional information, can lead to a better understanding of maximum saturated thickness in the tailings of Cell 2. Assuming for the moment that the Denison Mines (2011) Table F.1 32.5 feet value is correct, this means that the nominal base of the tailings must be, on average, at about 5613 ft amsl minus 32.5 feet, or 5580.5 ft amsl. Since, as calculated above, the head of water in the tailings is 5597.63 ft amsl, it follows that the average saturated thickness of the tailings in Cell 2 is 5597.63 ft amsl minus 5580.5 ft amsl, or 17.1 feet. This compares with a value of 12.03 feet claimed for maximum saturated thickness in the liquefaction sheet. The latter number appears to be off by 5.07 feet, which would be a 30% error. This may substantively change a number of liquefaction calculations. Please correct the saturated thickness in the liquefaction sheet.

From the previous calculations for Cell 2, it is observed that the saturated thickness is about 30% greater than claimed in the liquefaction analysis. This has effects on calculations for effective overburden stress and other consequent calculations. These effects can be accounted for to some extent. The saturated zone starts about 4.5 feet higher than shown on the liquefaction analysis sheet, at approximately 5597.63 ft amsl, not at 5593.03 ft amsl. This means that 4.6 feet of tailings must be accounted for with a 120.3 pcf saturated specific weight compared to old approach of (if that 4.6 feet of tailings is assumed to have a moist specific weight of 95.40 pcf). Secondly, it changes the values of effective stress at each deeper depth analyzed, since it also shifts the elevation vs. water pressure curve up. The Division request that EFR please make appropriate changes to the effective overburden stress calculations, or justify not doing so, not only for Cell 2, but for other cells, as needed.

In summary, based on a review of the information provided and in consideration of the issues previously discussed, the Division finds that several of the issues identified in the Interrogatory remain unaddressed, and consequently, the Division is unable to assess the correctness of EFR's conclusions regarding performance of the tailings impoundment cells

relative to liquefaction. In particular, no explicit discussion relating the results of the tailings dewatering analysis to the water levels used in the liquefaction analyses was presented. Also, parameters regarding the tailings characterization continue to be assumed (although now some are more conservatively selected) rather than being based on site-specific data. If assumed data are used, it should reflect the most reasonably conservative values possible. While adverse performance seems unlikely based on the relatively high factors of safety with respect to liquefaction potential currently calculated, there are enough inconsistencies in the analyses that further evaluation is merited.

10.0 Frost Penetration Analysis

10.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, APPENDIX A, CRITERION 6; INT 08/1; Technical Analyses – Frost Penetration Analysis

The interrogatory requested that EFR do the following:

Refer to Section 4.3 of Appendix D (Updated Tailings Cover Design Report) and Appendix B (Freeze/Thaw Modeling) to Appendix D to the Reclamation Plan Rev. 5.0:

1. Please revise freeze/thaw analyses to incorporate the following:
   a. Extrapolation of frost depth to recurrence interval to a minimum period of up to 1,000 years, to the extent practicable, or, to not less than 200 years, using a Gumbel extreme statistics (probability functions) approach (e.g., Smith and Rager 2002; Smith 1999; Yevjevich 1982).
   b. Additional justification for selection of an N -factor (surface temperature correction factor) of 0.6, instead of an N –factor of 0.7, based on published recommendations (e.g., DOE 1989).
   c. Additional justification that using climate data for Grand Junction, Colorado in the Berggren Model Formula (BMF) is representative of site conditions at the White Mesa site Address the considerably lower elevation and average warmer temperatures of Grand Junction compared to the White Mesa site. Either (1) prepare and report results of the BMF calculations using a default location having an elevation and Design Freezing Index equal to or greater than those of the White Mesa site AND mean average temperatures equal to or less than those of the White Mesa site OR (2) justify that the Grand Junction data is applicable and representative as input to the BMF calculations for the White Mesa site.
2. Based on the results of the revised frost penetration analysis, justify revised soil parameter values for soils within the cover system above the projected frost penetration depth considering the effects of repeated freezing and thawing over the recurrence interval considered (referred to in Item 1.a above). Use these parameter values in performance assessment modeling, including infiltration

modeling and radon attenuation modeling, consistent with recommendation provided in Sections 2.5 and 5.1 of NUREG-1620 (NRC 2003a).

3. If applicable after addressing the instructions stated above, revise Appendix B to Appendix D of the Reclamation Plan to ensure that all intended text is present in the document.

10.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 6; INT 10/1; Technical Analyses – Frost Penetration Analysis

IN ITS RESPONSE, EFR provided a revised frost depth penetration analysis for the currently proposed final cover system as Attachment C to its May 31, 2012 Response (partial) to the Round 1 Interrogatories on the Rev. 5.0 Reclamation Plan. The freeze/thaw analyses were revised to use Gumbel extreme statistics approach for a time period of 200 years. An N-factor of 0.7 and climate data from the Blanding, Utah was used for the analyses. The resulting frost penetration depth was estimated as 32 inches. EFR indicated that this frost analysis will be revised after approval of the conceptual final cover design has been obtained.

IN ITS RESPONSE, EFR also indicated that revised infiltration and radon emanation modeling have been completed that reflect modifications to the hydraulic and physical properties of the cover caused by freeze/thaw processes based on recommendations provided in Benson et al. 2011. The results of the revised modeling are provided as part of EFR's Response to the Round 1 Interrogatories on the Revised ICTM Report. EFR also indicated that Appendix B to Appendix D (Updated Tailings Cover Design Report) of the next revision of the Reclamation Plan will be updated to incorporate the revised freeze/thaw analyses.

10.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 6; INT 10/1; Technical Analyses – Frost Penetration Analysis

The May 31, 2012 EFR response and calculations and methodologies used for completing the revised frost depth analysis are considered acceptable, with the one exception described in the following paragraph.

The Division notes that in the revised infiltration and revised radon emanation modeling most recently completed by EFR, use of NRC-recommended adjusted porosity and bulk density values was not considered. The Division requests that EFR conduct a revised radon emanation modeling sensitivity analysis (as well as conduct a revised infiltration sensitivity analysis) for the approved final cover for a scenario that incorporates adjusted bulk density and porosity values (or adjusted appropriate other soil parameters in the infiltration analysis) for soils in the upper zone of the cover system potentially impacted by the predicted maximum frost penetration. Adjusted soil property values used in the simulations should either consist of adjusted values derived in a manner consistent with NRC recommendations for adjusting such properties in frost-impacted soils for radon flux

emanation calculations (NRC 2003a, Section 5.1.3), or adjusted values derived/assigned in manner consistent with recommendations provided in Benson et al. 2011, whichever is more conservative for the respective simulations. (See also discussion in Section 1.3 of the Technical Memorandum, White Mesa Mill Site – Revised ICTM Report Review addressing EFR's Response to Rd 1 Interrogatory 01/1 on the Revised Infiltration and Contaminant Transport Modeling Report).

The final revised Appendix B to Appendix D will need to be reviewed, when available, to verify that the revised frost depth information has been incorporated. The final revised frost depth analysis completed once the final cover design has been approved Drawings will need to be reviewed, when available, to verify that the revised frost depth calculation has addressed elements included in this request and has appropriately addressed any changes in the cover design, as applicable. Because these revised documents were not submitted with the response, this interrogatory will remain open.

11.0 Vegetation and Biointrusion Evaluation and Revegetation Plan

11.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A, INT 11/1; Vegetation and Biointrusion Evaluation and Revegetation Plan

The interrogatory requested that EFR do the following:

Refer to Section 1.7.1, 3.3.1.0 and Appendices D and J of the Reclamation Plan Rev. 5.0: Please provide the following:

1. Provide additional information (e.g., in the form of a survey and additional documentation of existing animal and vegetation species that exist at the White Mesa site and nearby surrounding region at this time to update the older information provided earlier.
2. Update the list of plant and animal species to include plant and animal species (e.g. burrowing animals) that could reasonably be expected to inhabit or colonize the White Mesa site within the required performance period of the embankment (1,000 years, and in no case less than 200 years). In revising these lists, account for the types of vegetation and soils present in the vicinity of the White Mesa site and proximity to the high quality northern pocket gopher and badger habitat indicated in Utah distribution maps (Utah Division of Wildlife Resources).
3. Please report the estimated range of burrowing depths and burrow densities for animal species found at the site and nearby surrounding region (once the updated study requested above is complete), and for burrowing species that may reasonably be expected to inhabit the site within the required performance period of the embankment (1,000 years, and in no case less than 200 years). Please comment on the root densities provided in Appendix D of the ICTM report. Indicate whether the correct root density units were used in Table D-3 and Figure D-1. Also verify that the correct values were used in the HYDRUS-2D infiltration model, since an erroneously

high value of root density could overestimate plant transpiration and underestimate infiltration.

4. Rectify the mischaracterization of two plant species as presented in the two referenced documents (Festuca ovina and common yarrow).
5. Provide additional documentation to support conclusions made regarding the ability of the proposed vegetation to establish at the cover percentages predicted. Also, provide additional discussion regarding the potential sustainability of the cover design and characteristics as proposed relative to changes that could occur due to the effects of natural succession and climate change during the performance period (1,000 years, and in no case less than 200 years).
6. Perform and report results of an additional infiltration sensitivity analysis to address the effects of deep-rooted plants projected by the updated analysis described above. In particular, account for any potentially deep-rooted species to assess the their effects of such deep-rooted species on the characteristics of soil layers in the embankment cover system. Please provide a forecasted percentage of potential species invasions in the ET cover system.

11.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan_5.0 R313-24-4; 10CFR40, Appendix A; INT 11/1; Vegetation and Biointrusion Evaluation and Revegetation Plan

IN ITS RESPONSE, EFR indicated the following:

1. *A plant and animal survey was conducted at the White Mesa site and surrounding area in June 2012 to update information provided in the Dames and Moore Environmental Report (1978). Plant cover was estimated along point intercept transects in the Big Sagebrush community type and through this survey the plant species that exist at the site and surrounding area have been updated and included in a revision of Appendix D to the Updated Tailings Cover Design Report (Appendix D of the Reclamation Plan, Revision 5.0). The revised appendix is provided as Attachment G. A survey of burrowing animals was also conducted with a focus on prairie dogs, badgers and northern pocket gophers. This survey was conducted in both the Big Sagebrush and Juniper communities either on site on in the surrounding area. Results for this survey are also presented in Attachment G;*

2. *A plant and animal survey was conducted at the White Mesa site and surrounding area in June 2012. The information from these surveys was used to update the list of plant and burrowing animal species that could reasonably be expected to inhabit or colonize the White Mesa site within the required performance period of 200 to 1,000 years. EFR indicated that the results of these surveys are included in Attachment G;*

3. *The estimated range of burrowing depths and burrow densities for animal species found at the site and nearby surrounding region are reported in Attachment G. The June 2012 animal survey conducted in the area of the Mill site provided burrow densities and an updated literature search was conducted on burrow depths for animal species that may reasonably be expected to inhabit the site within the required performance period;*

4. *The root densities provided in Appendix D of the Revised Infiltration and Contaminant Transport Modeling (ICTM) Report are incorrect because of a calculation error. Updated and recalculated root biomass values are shown in Table 1 below. These corrected values were used in the revised HYDRUS-1D infiltration model and results are provided as part of a second response document to the Revised ICTM Report;*

5. *The seed mixture proposed for the ET cover at the White Mesa Mill site consists of native and introduced species. The majority of species are native to Utah and two species (Pubescent wheatgrass and sheep fescue) have been introduced to North America. Sheep fescue was introduced from Europe in the 19th century, is commonly found in Utah and highly used as a reclamation species. Pubescent wheatgrass was introduced from Eurasia in 1907 and is also distributed in Utah from reclamation seedings over the past 100 years;*

6. *Common yarrow (Achillea millefolium, var. occidentalis) is native to North America and is found in Utah, according to the USDA Natural Resources Conservation Service's Plant Database (http://plants.usda.gov/java/). However, seed that is most available for common yarrow (Achillea millefolium) is of an introduced origin and is commonly used in reclamation plantings in Utah and throughout the western U.S. Seed of the native variety, occidentalis, will be used in the seed mixture if seed is available. If the native variety is not available, then the more common introduced variety will be used;*

7. *Galleta (Hilaria jamesii) has been added to the proposed seed mixture (Table 2), which can be found in the Attachment G. Galleta is a native warm season grass that is very common at the Mill site and makes an excellent addition to the proposed mixture;*

8. *Additional documentation to support conclusions made regarding the ability of the proposed vegetation to achieve predicted cover percentages is provided in the Attachment G. Plant cover was measured in the Big Sagebrush community and results support the predicted cover percentages for the plant community that will be established on the ET cover system. In addition, a more in-depth discussion is presented in Attachment G regarding potential sustainability of the cover design in relation to changes that could occur during natural succession and under possible climate change scenarios;*

9. *Revisions to the HYDRUS-1D infiltration model and results are provided as part of a second response document to the Revised ICTM Report; and*

10. A discussion of the forecasted percentages of potential species invasions in the ET cover system is provided in [Revised] Attachment G.

Table 1. Corrected Root Biomass (Anticipated Performance Scenario and Reduced Performance Scenario) for the White Mesa Mill Site

Depth (cm)	*Root Biomass Depth Anticipated Performance (g/cm^3)*	*Root Biomass Depth Reduced Performance (g/cm^3)*
0-15	*0.11*	*0.04*
15-30	*0.17*	*0.12*
30-45	*0.035*	*0.02*
45-60	*0.023*	*0.015*
60-75	*0.021*	*00.014**
75-90	*0.019*	*0.0*
90-107	*0.011*	*0.0*

* Maximum rooting depth under the reduced performance scenario would be 68 cm

Table 2. Species and Seeding Rates Proposed for ET Cover at the White Mesa Mill Site.

Scientific Name	***Common Name***	***Variety***	***Native/Introduced***	***Seeding Rate (lbs PLS/acre)†***
Grasses				
Pasccopyrum smithii	*Western wheatgrass*	*Arriba*	*Native*	*3.0*
Pseudoroegneria spicata	*Bluebunch wheatgrass*	*Goldar*	*Native*	*3.0*
Elymus trachycaulus	*Slender wheatgrass*	*San Luis*	*Native*	*2.0*
Elymus lanceolatus	*Streambank wheatgrass*	*Sodar*	*Native*	*2.0*
Elymus elymoides	*Squirreltail*	*Toe Jam*	*Native*	*2.0*
Thinopyrum intermedium	*Pubescent wheatgrass*	*Luna*	*Introduced*	*1.0*
Achnatherum hymenoides	*Indian ricegrass*	*Paloma*	*Native*	*4.0*
Poa secunda	*Sandberg bluegrass*	*Canbar*	*Native*	*0.5*
Festica ovina	*Sheep fescue*	*Covar*	*Introduced*	*1.0*
Bouteloua gracilis	*Blue grama*	*Hachita*	*Native*	*1.0*

Table 2. Species and Seeding Rates Proposed for ET Cover at the White Mesa Mill Site.

Scientific Name	*Common Name*	*Variety*	*Native/Introduced*	*Seeding Rate (lbs PLS/acre)†*
Hilaria jamesii	*Galleta*	*Viva*	*Native*	*2.0*
Forbs				
Achillea millefolium var. occidentalis	*Common yarrow*	*No Variety*	*Native*	*0.5*
Artemesia ludovociana	*White Sage*	*No Variety*	*Native*	*0.5*
Total				*23.0*

†Seeding rate is for broadcast seed and presented as pounds of pure live seed per acre (lbs PLS/acre)
‡ Introduced refers to species that have been 'introduced' from another geographic region, typically outside of
North America. Also referred to as 'exotic' species.

11.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A; INT 11/1; Vegetation and Biointrusion Evaluation and Revegetation Plan

The Division finds that EFR has addressed, in part, the items included in the interrogatory and considerable useful new information has been provided. However, some additional information is still needed to complete the responses, as described in the following paragraphs.

EFR presented results of the vegetation survey in summary fashion and provided few details. Are there survey reports describing methods and results in greater detail? Is there data available for each transect location? Is there information on other plant species observed but that did not have cover recorded at the transect points? The vegetation survey results did not include an updated vegetation map or information on the current vegetation in the reclamation cells. The map in the September 2011 Reclamation Plan (Revision 5.0) is clearly inconsistent with the results of the vegetation sampling reported in the August 15, 2012 Responses to Interrogatories, in that 19.1% big sagebrush cover was found at sample sites that are located in areas shown in Figure 17-1 as reseeded grassland and controlled big sagebrush. Information should have been provided on the current vegetation of the reclamation cells. The information provided does not provide an adequate account of current vegetation or an explanation of the successional processes that have occurred following previous disturbances and reclamation efforts.

Attachment G provides an updated seed mix, which now includes galleta. The total seeding rate in Table D.1 needs to be corrected to be 22.5 lbs PLS/acre. A column of PLS/square foot should be added to this table (this information was previously provided for most

species in the September 2011 Appendix J Reclamation Plan). This mix is now correctly characterized as containing both native and introduced species.

Information was provided on the ecological characteristics of each of the species in the seed mix. However, no information was provided regarding past success or failure with these species at the site during interim reclamation. Previous revegetation experience at the site and changes in composition and cover over time, if available, need to be presented in order to support the predicted cover percentages.

Table D.4. Please provide more explanation as to how the values in this table were derived.

Table D.9 provides levels of soil properties for stockpiled soils compared to sustainable levels reported in the literature. These "sustainable levels" may or may not be achievable or sustainable over a long term within the study area, depending on its environment. To help determine realistic long-term expectations, soil properties should also be measured at reference areas. To what extent will establishment of grassland vegetation contribute to developing soil properties supporting sustainable vegetation?

The description of organic matter and nutrient amendments lacks sufficient detail. Provide more information regarding quantities, potential sources, and suitability for sustained growth?

How will institutional control be used to exclude grazing by livestock for the performance period?

Weeds and weed management should be addressed. It is noted that a significant portion of the vegetation over in the sagebrush areas surrounding the White Mesa Mill Site comes from cheatgrass and Russian thistle, and that cheatgrass and jointed goat grass initially dominated revegetation areas at Monticello.. What other weeds occur in the area or may occur in the future? Use of a mix of hay and manure to provide soil organic matter could introduce weeds.

Section D.4.5. of Attachment G , Supporting Documentation for (Rd 1) Interrogatory 11/1 (Revised Appendix D to the Updated Tailings Cover Design Report), first sentence indicates that "monitoring of an alternative cover at the Monticello Mill Tailings Disposal Site showed that the plant cover performed well over a seven year period." The last phrase "plant cover performed well over a seven year period" should be reworded because although cover goals for grasses were met later in the 7-year period, cover goals established for the Monticello cover for shrubs species were not achieved despite significant shrub planting efforts in in 2000 and in 2007 (e.g., see Sheader and Kastens [undated] circa 2007). Please provide a reference for the statement that eight species provided 70% of the plant cover at Monticello. The text in Revised Appendix D does not provide an indication of the percentage vegetative cover comprised by weedy species including weedy cheatgrass and Russian Thistle over that time period at Monticello and does not discuss how these species may affect cover revegetation goals (evapotranspiration capabilities) established for the Monticello or White Mesa cover systems.

Section D.7.2 addresses succession, including increase in sagebrush cover. The discussion should acknowledge the establishment of big sagebrush and other shrubs on former seeded

grassland and controlled sagebrush areas north of the Mill Site in the 35 years since the original vegetation study, and discuss its relevance to the revegetation plan. The discussion indicates that warm season grasses are expected to increase over time. Is there an existing vegetation community in the region similar to that which is expected to develop? The discussion also mentions pulse-dominated precipitation – are there expected changes in seasonality of precipitation? An explanation should be provided as to why shrub species that occur just south of, and at lower elevations than the tailings management areas location, , such as four-wing saltbush, shadscale, blackbrush, and Mormon tea, would not increase under potentially warmer and dryer future climate conditions at the site.

The Reclamation Plan (or revised Infiltration and Contaminant Transport Report) needs to provide: (1) definition of clear, concise, and measurable revegetation acceptance goals/criteria for the vegetation establishment on the tailings cell cover system, (2) a description of how EFR will conduct periodic post-closure monitoring and reporting to the Division of the vegetation community health, viability, success, and sustainability, (3) a description of proposed action plans, schedules and deadlines for remedial actions if/when needed to effectuate plant community success, and (4) similar follow-up monitoring of the plant community/cover system to ensure successful performance before release of the facility's surety bond and/or transfer of title to DOE. EFR should describe specific, quantitative goals for shrub establishment (including rooting depths and minimum acceptable shrub cover percentages) that consider the need for deeper rooted plants to remove water that may accumulate lower in the cover profile in response to an exceptionally wet year or successive wet years, especially given the lack of a capillary break layer in the currently proposed cover design. In developing these descriptions, plans, and goals, EFR should consider and address lessons learned from the post-closure monitoring and maintenance activities and/or corrective revegetation measures required at the Monticello, Utah tailings repository and other similar facilities in this regard (e.g., Waugh 2008; Sheader and Kastens undated, circa 2007; U.S. DOE 2007; Sheader and Kastens [undated, circa 2007). EFR should assess the potential applicability and benefits of using vegetation health monitoring tools/metrics such as the Cover Vegetation Index recently implemented at the Monticello Repository (U.S. DOE 2009).

The Reclamation Plan should describe corrective measures that may be needed to address/correct issues related to: (1) establishment of undesirable species, e.g., colonization by certain undesired grass/weedy species that may have more limited water stress tolerance than initially seeded grass species and/or that may outcompete planted grass species unless controlled (e.g., Smesrud et al. 2012; Sheader and Kastens [undated, circa 2007]); (2) Seed predation following seeding/reseeding efforts; (3)Possible low success rates resulting from for shrub establishment efforts, etc.... Estimated costs for conducting these post-closure activities, corrective actions, and reporting, once approved by the Division, will need to be incorporated in the financial surety estimate.

The Revised Attachment G provided by EFR as part of its Response presents the results of a June 1012 burrowing animal survey (Section D.5.3). However, as described above, the results are presented in summary fashion and few of the necessary details are provided.

Are there survey reports describing methods and results in greater detail? Is there data available for each transect location? Does badger burrow density include feeding areas (dug-out prey burrows)? The reported burrow density for badger appears very low. Additional information about potential burrow densities should be provided based on a review of the literature. The analysis should consider both burrows dug by badgers for their own use and digging while hunting.

Little information is presented on burrow densities, other than Gunnison prairie dog. Results for Gunnison prairie dog are based on the June 2012 survey and do not consider literature values. Information on burrow densities for Gunnison prairie dog should be summarized by transect and the locations of prairie dog towns marked on a map. The results need to be put in context by reference to literature, for example Lupis et al. 2007, considering both regional densities, predicted range and habitat suitability. The statement in Attachment D that prairie dogs are unlikely to occur because they prefer low plant cover and short vegetation is not consistent with the description of habitats where they occur in southeastern Utah in Lupis et al. 2007. Most of the grass species included in the seed mix are reported to occur in grassland habitat occupied by this species in southeastern Utah. They also occupy desert shrub habitats.

Table D.8. Ranges of depths for burrowing mammals mostly not provided, just maximum depth, and based on a single citation per species. The "maximum" depth for Gunnison's prairie dog of 122 cm from Verdolin et al 2008 should be correctly characterized as an average depth reported from several studies. The actual maximum (mean plus 1 SD) reported by Verdolin et al. 2008 appears to be 1.85 m. All of the numbers in this table should be revisited to provide a range of maximum values reported in the literature and to determine whether the maximum has been accurately stated.

Table D.6 and discussion. There is literature indicating that big sagebrush can root to depths considerably below 180 cm. Please address and further explain this finding/statement. Rooting depths of other shrubs that may occur should also be considered.

Additional information needs to be presented to justify that the highly compacted zone will minimize biointrusion by plant roots. Consider moisture conditions, potential degradation when dry, behavior of roots related to soil moisture and gas exchange, and other factors. Cite previous studies or observations of root growth relative to compacted soils.

12.0 Report Radon Barrier Effectiveness

12.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 6(4); INT 12/1; Report Radon Barrier Effectiveness

The interrogatory requested that EFR do the following:

Refer to Reclamation Plan Rev. 5.0, Section 3 (Tailings Reclamation Plan) and Appendix D (Updated Tailings Cover Design Report dated Sept 2011):

Please revise radon flux calculations using actual site-specific material properties data.

a. Clearly demonstrate that values of material parameters:

   1) Are reasonably conservative

   2) Are based on site material samples, measured values, assumptions, or other origins

   3) Are based upon appropriate analytical methods and sufficient number of representative samples for cover soils and tailings

   4) Consider the variability and uncertainties in actual site-specific data.

   5) Are consistent with anticipated construction specifications

   6) Are based upon representative long-term site conditions.

b. Justify values of material parameters used in the radon flux calculations

c. Demonstrate that test methods and their precision, accuracy, and applicability are supported by suitable standards and procedures.

d. Justify that values chosen for radon emanation and diffusion coefficients are consistent with long-term moisture contents projected to exist within tailings and cover materials in the impoundments.

e. Demonstrate that the quality assurance program used in obtaining parameter data is adequate

f. Revise the design density and porosity values of cover soils to comply with the usual compaction of 95% of Standard Proctor (D 698). Alternatively, clearly justify the basis for the lower compactions utilized in the radon flux calculations and their expected long-term stability.

g. Please revise the tailings density, porosity, and moisture values to reflect expected long-term conditions in each of the disposal units. Alternatively, demonstrate the basis for the long-term stability of the values used in the radon flux calculations.

h. Please utilize one of the two accepted methods for long-term moisture estimates (D 2325 or Rawls correlation) with representative samples. Alternatively, justify the use of an acceptable alternative method.

i. Please resolve or justify the discrepancy between the 91.4 pcf "best correlation" between the Rawls and in-situ moisture data (Appendix D page C-4) and the density range of 94 to 111 pcf used in the radon flux calculations. Revise and report results of radon flux calculations, as necessary to reflect the resulting changes.

j. Please utilize a source term based on representative sampling and analysis of the sand, slime, and mixed tailings to 12-ft depths in sufficient and representative locations of each tailings area (e.g., Cells 2, 3, 4A, and 4B.). Alternatively, justify and use the average ore grade method identified in Reg Guide 3.64 for the radon flux calculations.

k. Please justify the assumed value of zero for Ra-226 concentrations in cover soils by sampling and measurement of background Ra-226 soil concentrations and comparison of their values with corresponding representative measurements in the proposed cover soils. Alternatively, use values of Ra-226 concentrations in radon flux calculations that are supported by cell-specific measurements.

l. Please utilize measured radon emanation coefficients that are representative of the sand, slime, and mixed tailings in the various tailings cell areas; emanation coefficients averaged over measurements for each tailings cell. Alternatively, use default values conservatively estimated from site-specific measurements.

m. Please utilize measured or calculated radon diffusion coefficients in radon flux calculations that represent the long-term properties of the tailings and cover soil materials.

n. Please provide written procedures for identifying and placing contaminated soils into the disposal cell(s) and substantiating characterization data and site history.

o. Provide a revised radon emanation model that incorporates lower values of initial bulk density for the erosion protection layer in the model. The bulk density value selected needs to fall within the range of bulk densities that is recommended (approximately 1.2 to 1.8 g/cm3, or about 75 to 112 pcf) in the section entitled "Soil Requirements for Sustainable Plant Growth" and listed in Table D-5 in Appendix D to the Reclamation Plan as the recommended range required for promoting sustainable plant growth.

12.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan_5.0 R313-24-4; 10CFR40, Appendix A, Criterion 6(4); INT 12/1; Report Radon Barrier Effectiveness

IN ITS RESPONSE, EFR indicated the following:

A site investigation to further evaluate cover borrow materials was conducted on April 19, 2012. The results of laboratory testing on samples collected from the April 2012 investigation were used to develop updated cover material parameters for radon emanation modeling. In addition, other model parameters were further evaluated as necessary to address comments in this interrogatory. The results of the updated analyses are provided in Attachment H as part of the revised Appendix C, Radon Emanation Modeling, which will be included in the next version of the Updated Tailings Cover Design Report (Appendix D of the Reclamation Plan).

The radon emanation coefficient parameter was revised for the updated radon analyses presented in Attachment H to be 0.20 based on recommendations in NUREG-1620 (NRC, 2003) that states a "value of 0.20 may be estimated for tailings based on the literature, if supported by limited site-specific measurements."

A radon coefficient used in the model for the cover layers was revised to be 0.35 for the updated radon analyses presented in Attachment H. A value of 0.35 is the conservative default value used in the RADON model.

The radon diffusion coefficients can be calculated within the RADON model or input directly using measured values (NRC, 2003). Although laboratory test data was available, the tests were performed at porosities and water contents different than those estimated to represent long-term conditions in the model. Therefore the values were calculated within the RADON model. The revised radon modeling also used radon diffusion coefficients that are calculated within the model.

The cover design consists of an evapotranspiration cover. The water storage layer will be compacted to 85 percent of standard Proctor density and the lower random fill layer is estimated to be compacted to 80 percent of standard Proctor density. Use of design density and porosity values corresponding to 95 percent of standard Proctor density would be inconsistent with the cover design.

The long-term tailings density was revised to be 90 pcf, based on laboratory tests (Chen and Associates, 1987 and Western Colorado Testing, 1999) and assuming the long-term density of the tailings is at 85 percent of the average laboratory measured maximum dry density. The porosity of the tailings was calculated using the dry density and the average measured specific gravity of 2.75 based on laboratory tests (Chen and Associates, 1987 and Western Colorado Testing, 1999).

The long-term moisture content value for the tailings was assumed to be 6 percent in the analyses presented in Denison (2011). This is the same value that was used for the revised radon analyses. This is a conservative assumption, per NRC Regulatory Guide 3.64 (NRC, 1989), which represents the lower bound for moisture in western soils and is typically used as a default value for the long-term water content of tailings.

Laboratory results for the 15 bar water contents for select samples from the April 19, 2012 field investigation were used to estimate long-term water contents for the random fill and erosion protection layers. This is discussed further in Attachment H.

The radon analyses were updated using the revised estimates for long-term water contents. This response supersedes the response provided in the response document submitted May 31, 2012.

The revised estimation of the radium-226 concentration activities used for the tailings is provided in Attachment H.

Denison has established background values for Ra-226 in surface soil in the White Mesa Mill area. These background values are very low, due to the absence of uranium mineralization in the mill area. The cover soils that have been stockpiled are derived from the same geologic formations as the soils measured for background values. Therefore a Ra-226 value for cover soils of zero is appropriate in the radon flux modeling, as outlined in NRC Regulatory Guide 3.64.

Procedures for identifying and placing contaminated soils is provided in Attachment A (Plans and Technical Specifications) of the Reclamation Plan. Additional information on procedures for identifying contaminated soils is provided in the responses to Interrogatory 20/1.

The density of the rock mulch erosion protection layer was revised to be based on the additional laboratory testing of potential cover soils (see Attachment B.2). The previous density of the rock mulch provided in Appendix D of the Reclamation Plan should was incorrectly listed as 124.2 pcf. It should have been listed as 107 pcf based on the historical laboratory testing results. The updated rock mulch density is 106 pcf. This value was used in the radon modeling.

12.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 6(4); INT 12/1; <u>Report Radon Barrier Effectiveness</u>

The Division's assessment of the Response follows below:

As with a number other responses, EFR has deferred final resolution of issues to its submission of the next revision of the Reclamation Plan. The Division requests that EFR please submit the next revision of the Reclamation Plan that incorporates all changes proposed in the license amendment request.

EFR's responses leave unresolved the following issues regarding radon flux modeling:

1. **The dependence of Radon emanation and diffusion coefficient on long-term moisture content (raised in Item d of INT 12/1) is not but should be addressed. Please address this dependence. [Note: The Division notes that the radon diffusion coefficient used in the revised radon emanation analysis for the tailings is higher (by about a factor of 3) than the diffusion coefficient value assumed in radon emanation analyses competed for a similar tailings disposal facility (Monticello Tailings Repository) in Utah (e.g., NRC 2008). The value used in the Monticello analysis was derived using a different procedure (Rogers and Nielson 1991) than was used by EFR. Using a higher radon diffusion coefficient in the radon emanation analysis represents a more conservative assumption.]**
2. **The summary of values used for long-term moisture content does not adequately explain the work presented in Attachment H, Attachment C.2. This lack of**

supporting interpretation basis leaves unresolved the conclusion that the values used in Radon modeling are conservative. Please complete the discussion of values of long-term moisture content used in Radon modeling.

3. **Values summarized in Table C-4 for diffusion coefficients are inconsistent with those appearing in Attachment H, Attachment C.3. Please resolve this inconsistency**
4. **All calculated Radon fluxes from the surface of the cover system (Layer 5) exceed 20 pCi/cm^2-s, albeit by very slight amounts. Please address the apparent failure of the proposed cover system design to satisfy the regulatory constraint for Radon flux.**

13.0 Concentrations of Radionuclides Other Than Radium

13.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 6(6); INT 13/1; Concentrations of Radionuclides Other Than Radium

The interrogatory requested that EFR do the following:

1. Please propose appropriate soil background values (for different geological areas as needed) for Ra-226, U-nat, Th-230, and/or Th-232, as appropriate, with supporting data.

2. Please indicate whether elevated levels of uranium or thorium are expected to remain in the soil after the Ra-226 criteria have been met, and if so, describe your use of the radium benchmark dose approach (Appendix H of NUREG-1620) for developing decommissioning criteria for these radionuclides.

3. Please provide a description of the instruments and procedures that will be used for soil background analyses, radium-gamma correlations, and verification data along with information about the sensitivity of the procedures.

4. Please provide final verification (status survey) procedures to demonstrate compliance with the soil and structure cleanup standards. The procedures should specify instruments, calibrations, and testing, and the verification soil sampling density should take into consideration detection limits of samples analyses, the extent of expected contamination, and limits to the gamma survey. The gamma guideline value should be appropriately chosen, and the verification soil radium-gamma correlation should be provided along with the number of verification grids that had additional removal because of excessive Ra-226 values. The plan should provide for adequate data collection beyond the excavation boundary. Surface activity measurements should demonstrate acceptable compliance with surface dose standards for any structures to remain onsite.

13.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 6(6); INT 13/1; Concentrations of Radionuclides Other Than Radium

IN ITS RESPONSE, EFR indicated the following:

"The White Mesa Mill reports quarterly composite environmental air particulate data for U-nat, Th-230, Ra-226 and Pb-210. The results of the environmental air sampling presented in the Mill's Semi Annual Effluent Reports show concentrations well below the Mill's ALARA goal of 25% of the regulatory standard for each radionuclide. Each of these four radionuclides were considered in setting reference soil concentrations for reclamation.

The reference soil concentrations for Ra-226 are set at 5 pCi/g and 15 pCi/g for the surface 15 cm soil layer and the subsurface 15 cm soil layer, respectively (hereafter referred to as "5/15"). The dose from Pb-210, which due to its short half-life is assumed to be in equilibrium with the parent Ra-226, was assigned to the dose from Ra-226. (See Attachment I for further discussion.) The site does not contain thorium byproduct material, therefore Ra-228 and Th-232 are not applicable.

The soil concentration limits for radionuclides other than Ra-226 are derived from doses calculated for Ra-226 at 5/15 using the same exposure scenarios as were used to estimate the dose from Ra-226 at 5/15. This is referred to as the radium benchmark dose (RBD). This approach was used to establish soil concentration limits for U-nat and Th-230.

Based on available data, the preliminary estimate of background for Ra-226 is the average concentration at the site background location (BHV-3) which is 0.93 pCi/g Ra- 226 as indicated in Section 6.6 of Attachment A. The 0.93 pCi/g Ra-226 background concentration is close to nearby measurements from a background program with values of 1.1 pCi/g Ra-226 near the airport entrance south of Blanding and 0.83 pCi/g Ra-226 southeast of Crescent Junction (Myrick et. al., 1981). The 32 Utah measurements ranged from 0.53 to 1.9 pCi/g with an average of 1.3 pCi/g and a standard deviation of 0.74 pCi/g. In addition, Energy Fuels may use site-specific pre-mill background soil concentrations if this information is available.

Preliminary estimates of background for U-nat and Th-230 are based on the Ra-226 concentration on the assumption of secular equilibrium for natural materials. Therefore, the predicted U-nat background is 1.90 pCi/g (i.e., 2.051 times 0.93 pCi/g) with the Th- 230 background concentration set equal to 0.93 pCi/g.

These preliminary estimates of background concentrations are considered suitable for the scoping survey; however, as recommended in the MARSSIM guidance, a site-specific sampling program will be conducted prior to final status survey with the locations selected with similar

geology (surface soil) as the White Mesa areas, in order to determine the background concentrations to be used for final decommissioning.

Generally, elevation of U-nat and Th-230 concentrations relative to Ra-226 is unexpected since the contaminated materials will either be ore (which are at or near secular equilibrium) or tailings where U-nat is reduced relative to the other uranium decay series radionuclides of interest. Possible exceptions are areas with raffinate crystals which may have higher Th-230 concentrations compared to Ra-226 concentrations and areas of spilled yellowcake product near the Mill where U-nat may be elevated relative to Ra-226.

The RBD approach was applied as described in Attachment I. The RESRAD (Version 6.5) code [Yu et al. 2001] was used to implement the RBD approach. The RESRAD code is an accepted code by the NRC for application of the radium benchmark dose approach as described in Guidance to the NRC Commission Staff on the Radium Benchmark Dose Approach, a document included in NUREG-1569 as Appendix E (NRC 2003b). In brief, radionuclides at the reference soil concentration limits result in the same benchmark dose as the allowable Ra-226 concentration.

The concentration limits for the radionuclides of interest were calculated and are provided in Table 1 for the surface and subsurface layers. The scenario is for a rancher with the doses determined using the RESRAD Version 6.5 model. The default RESRAD dietary and inhalation data which apply for the adult are carefully selected from literature and are already considered to represent conservative parameter values. Details on the calculation of concentration limits are provided in Attachment I (the SENES letter report on RBD).

Table 1. Incremental Concentration Limits Based on Radium Benchmark Dose

Incremental Concentration Limit (pCi/g)		
Radionuclide	***Surface Layer***	***Subsurface Layer***
U-nat	*545*	*2908*
Th-230	*46*	*142*
Ra-226	*5* [a]	*15* [a]

Notes.
a Allowable incremental Ra-226 concentration

Since there is more than one radionuclide, the criteria for unrestricted use is applied using the unity rule such that the RBD is never exceeded (i.e., the sum of the ratios for each radionuclide incremental concentration present to the concentration limit will not exceed "1").

The concentration in the numerator is determined by subtracting the local background from the total measured value following remediation. It is possible that the background may vary between survey units due to variation in soil types.

The sum rules are:

For the surface soil:

$$\frac{A\ (pCi/g\ inc.Ra-226)}{5\ (pCi/g)}+\frac{B\ (pCi/g\ inc.U-nat)}{545\ (pCi/g)}+\frac{C\ (pCi/g\ inc.Th-230)}{40\ (pCi/g)}\leq 1$$

For the subsurface soil:

$$\frac{A\ (pCi/g\ inc.Ra-226)}{15\ (pCi/g)}+\frac{B\ (pCi/g\ inc.U-nat)}{2908\ (pCi/g)}+\frac{C\ (pCi/g\ inc.Th-230)}{142\ (pCi/g)}\leq 1$$

EFR indicated that uranium ores arriving at the mill require very aggressive extraction in the mill in order to recover uranium. EFR stated that this suggests that the uranium in ores processed at the Mill is in an insoluble form. Similarly, residual uranium in solids discharged to the tailings was not extracted through the mill process and can reasonably be assumed to be in an insoluble form. Thus, EFR concluded that it is reasonable to assume that any incremental (to background) uranium remaining following remediation is most likely to be in non-soluble forms and hence, chemical toxicity of uranium, which is dependent on exposure to soluble forms, is not considered.

EFR stated that gamma radiation surveys will be conducted either with the existing Ludlum-19 methodology that has been used for operational monitoring as well as previous remediation at White Mesa, or with a GPS-integrated system using 2 inch by 2 inch sodium iodide (NaI) detectors or the equivalent. Descriptions of the existing Ludlum-19 instrument and standard operating procedures are provided in the Mill's Radiation Protection Reclamation Manual. Procedures for the GPS-integrated survey will be developed if that approach is to be used.

Statistical correlations will be developed between the sum rule and the gamma radiation measurements. The sum rule will be determined from measurement data for incremental concentrations at each sample location. The correlation between the measurement sum rule and the gamma radiation measurement at the sample location will produce a prediction equation. MARSSIM requires that the mean concentration in a survey unit be demonstrably lower than criteria following remediation but does not require all sampling units, in this case the 10 meter by 10 meter areas, to be lower than the criteria. The precision goal for the relationship will be that the mean prediction uncertainty for the survey unit will be +/- 0.2 when the predicted sum rule is equal to "1".

The selected alpha error will be 0.05. The initial number of samples will be 15 and the correlations will be assessed following the scoping survey and additional measurement locations will be added, if necessary, to reach suitable precision. Although, final verification requires that the mean is statistically below the criterion, the EFR goal will be to remediate each 10 meter by 10 meter block, or sampling unit, so that the predicted sum rule meets the criterion of "1".

The final verification survey will be focused on ensuring that the excavation of remediation areas has been established.

Gamma Radiation Surveys

Locations within the survey areas where excavation has been performed will have a gamma radiation scan. Survey procedures with the Ludlum-19 methodology would follow the existing procedures provided in the Mill's Radiation Protection Reclamation Manual.

With the GPS-integrated methodology, high density gamma radiation scanning surveys can be done using the un-collimated Ludlum 44-10 detectors at a height of 18 inches above the ground. Transects are planned to be 5 m apart to facilitate calculation of 10 meter by 10 meter averages, and this coverage will continue up to 20 meters outside the excavation outline. These locations would correspond to a Class I classification in the Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM NUREG- 1575). The remainder of the survey area outside the remediation area corresponds to Class II in MARSSIM and will be surveyed at planned 10 meter transects. The gamma radiation coverage goal will be that 95% of the 10 meter by 10 meter blocks have at least 20 gamma radiation measurements for blocks in and immediately surrounding the excavation areas with measurements in at least three of the four quadrants of the 10 meter by 10 meter block. The requirement for the remainder of the survey area, Class 2, will be that 95% of the blocks have at least 10 gamma radiation measurements.

The Class 3 area will include the buffer areas outside the area of contamination, and this area will be surveyed with planned transects of 50 meters. The requirement here is that 20% of the 10 meter by 10 meter blocks have at least 10 measurements.

Gamma Radiation Guideline Level

The gamma radiation data will be processed to establish the average gamma radiation count rate over the 10 meter by 10 meter blocks. A correlation relationship will be established between the gamma radiation level and the measured sum rule using coincident gamma radiation and soil concentration measurements. The gamma radiation guideline value will be the value such that the predicted mean is 0.8 for the correlation relationship defined for the survey area and the DQO for 10 meter by 10 meter blocks has been attained for gamma radiation. Locations where the gamma radiation guideline is exceeded will have additional excavation and updated gamma radiation surveys before confirmatory sampling.

Selection of Verification Samples

Following completion of excavation, verification sampling will be carried out to meet two objectives with the first being confirmation of the correlation equation and second, an independent evaluation of the criteria based on soil samples alone. Locations for the initial verification sampling will be established based on a combined selection of sampling points using process history and a random sampling approach for each investigation area. Following a final status gamma radiation survey, a minimum of 15 blocks in the survey unit will be measured to confirm the gamma radiation guideline level. For these 15 samples, the five 10 meter by 10 meter blocks with the highest average gamma radiation will be sampled along with another 10 sample blocks randomly selected from the area.

The soil measurements from the 10 randomly selected locations will be assessed to determine if the mean concentration in the survey unit is statistically below the sum rule with an alpha error of 0.05 using the MARSSIM Sign test. (The Sign test is used because the sum rule involves incremental above background concentrations.)

However, the statistical test could fail to show that the mean is below the criterion due to the initial number of verification samples. In this case, the mean and variability of the 10 randomly selected measurements will be used to determine MARSSIM's relative shift with a target grey error equal to 0.8 of the sum rule. The alpha error will be set to 5% and the beta error set to 10% to determine the required total number of samples. A random sample will be determined for collection of the required number of additional samples.

Revision of Correlation

The verification sample measurements will be compared to the correlation predictions to determine if the correlation consistently over or under-predicts (i.e. is biased) the sum rule. The correlation will be updated with the verification measurements if there is a statistically significant departure, with a p-value of 0.05, over the range of interest (sum rule from 0.5 to 1.0) evaluated using the paired difference between the predicted sum rule using the correlation and the measured sum rule.

Reporting

For each survey area, the following will be reported:

1. *Number of blocks remediated during remediation phase.*

2. *Number of blocks with subsequent remediation initiated by verification gamma radiation sampling.*

3. *Gamma radiation coverage compliance (i.e. percentage of blocks meeting number of measurement criteria).*

4. *Mean gamma radiation level averaged over the 10 meter by 10 meter blocks.*

5. *Mean and range of predicted sum rules based on gamma radiation survey.*

6. *Mean and range of measured sum rules based on verification sampling.*

1. *Only clean, uncontaminated buildings, such as office space may remain after reclamation."*

13.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 6(6); INT 13/1; <u>Concentrations of Radionuclides Other Than Radium</u>

To further resolve remaining issues pertaining to concentrations of radionuclides other than radium in soil, the Division requests that EFR please do the following:

1) **Provide justification (either data or references to data) to support EFR's determination of U-nat and Th-230 background concentrations.**

2) **Incorporate a description of how EFR's site-specific sampling program will be used to determine background concentrations for radionuclides other than Ra-226 into EFR's documentation of how MARSSIM will be implemented and submit for the Division's review.**

3) **Incorporate a description of how EFR will use the "sum rules" for surface and subsurface soils into EFR's documentation of how MARSSIM will be implemented and submit for the Division's review.**

4) **Incorporate a description of EFR's plan for using radiation measurement instrumentation for soil background analyses, radium-gamma correlations, verification data, and sensitivity analyses into EFR's documentation of how MARSSIM will be implemented and submit for the Division's review.**

5) **As suggested in Item 4 of INT 13/1, please incorporate into documentation relating to how MARSSIM will be implemented, descriptions of the following:**

   - ✓ **Calibration procedures**
   - ✓ **Instrument testing**
   - ✓ **Detection limits of sample analyses**
   - ✓ **Extent of expected contamination**

- ✓ **Limits of gamma survey**
- ✓ **Verification of the soil-radium gamma correlation**

14.0 Cover Test Section and Test Pad Monitoring Programs

14.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A; INT 14/1; Cover Test Section and Test Pad Monitoring Programs

The interrogatory requested that EFR do the following:

Refer to Section 8.0 of Attachment A (Technical Specifications and Attachment B (Construction Quality Assurance/Quality Control Plan) to the Reclamation Plan and Section 5.0 of Appendix D (Updated Tailings Cover Design Report) of the Reclamation Plan Rev. 5.0 (DUSA 2011a):

1. Please provide plans and specifications for constructing and performing monitoring and testing of a cover system section representative of the proposed ET cover system for verifying the hydraulic performance characteristics of the cover system. Demonstrate that the proposed test pad/plot will be sufficient in size to eliminate or minimize lateral boundary effects. Describe objectives and criteria for construction and testing of the test pad cover materials /layers. Include information in the CQAQC Plan regarding procedures for sampling and testing of the cover system section specifically pertinent to demonstrating the (short-term and long-term) performance of the ET cell cover design. Address, as part of the testing program, testing of parameters specifically recommended by Benson et al. 2011; Waugh et al. 2008; the National Research Council 2007; Albright et al. 2007; others) including, but not necessarily limited to:

    a. Monitoring of in-situ soil water tension and volumetric water content as a function of time (e.g., using heat dissipation probes and TDR [time domain reflectometry]);

    b. Monitoring of in-situ flux rates as a function of time (e.g., through use of one or more pan lysimeters as recommended by Benson et al. 2011 and Dwyer et al. 2007) on both north and south-facing slopes as required);

    c. Physical sampling and laboratory testing for index properties, including Plasticity Index and saturated hydraulic conductivity, and other pertinent parameters including compaction properties, organic matter and CaCO3 content, and measurement of soil edaphic properties (properties that influence vegetation establishment and growth – e.g., see Waugh et al. 2008);

    d. Other testing if needed for determining changes in water in storage and soil water characteristic curves (SWCCs, e.g., according to ASTM D6836 [ASTM 2008]) and monitoring for potential changes in SWCCs through time;

    e. Conducting soil vegetation surveys (as recommended by Benson et al. 2011); and

f. Monitoring of relevant climatological parameters (precipitation and evaporation rates, temperature, barometric pressure, snow amounts, wind speed and wind direction, etc...), including continuous monitoring over several years necessary to understand how covers are influenced by fluctuations in climate and other environmental factors (Waugh et al. 2008) such as an extraordinarily wet year or consecutive wet years.

2. Provide additional information and plans and specifications for constructing and testing a cover system "test pad/test plot" prior to construction of the proposed ET cover system over the consolidated, dewatered tailings. Demonstrate that the proposed test pad/plot will be sufficient in size to eliminate or minimize lateral boundary effects. Describe objectives and criteria for construction and testing of the test pad cover materials /layers including but not limited to:

   a. Acquisition of data of the types described in Item 1. Above;

   b. Determination of an acceptable zone (AZ) for soil textures in soils used for constructing the final cover system (e.g., Williams et al. 2010);

   c. Determination of most effective means of "bonding" individual soil cover soil layers (e.g., Dwyer et al. 2007); and

   d. Determination of appropriate lift thickness/placement and compaction equipment combinations (e.g., Dwyer et al. 2007).

14.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, Appendix A; INT 14/1; Cover Test Section and Test Pad Monitoring Programs

IN ITS RESPONSE, EFR proposes to use a "performance monitoring section" to evaluate performance of the final tailings cover system. The conceptual design will be adopted from the installation instructions for the test sections used in the Alternative Cover Assessment Program (ACAP) (Benson et al., 1999) and will incorporate the performance monitoring recommendations provided in NUREG/CR-7028 (Benson et al., 2011) and site-specific recommendations provided by Dr. Craig H. Benson (Craig H. Benson, personal communication, May 8, 2012). EFR proposes to provide detailed plans, specifications, and a QA/QC plan following the Division's approval of the proposed performance monitoring [program].

IN ITS RESPONSE, EFR also proposes not to construct or observe performance of a cover system test pad prior to construction of the final cover system. Instead, EFR argues that observed performance of the nearby closed Monticello Uranium Mill Tailings Disposal Facility provides a reasonable basis for inferring performance of the proposed final cover system design. EFR identifies two additional features of the proposed White Mesa design that are not present in the Monticello design. a biointrusion layer and a sand drainage layer. EFR argues that these

differences have opposite effects on White Mesa performance relative to Monticello performance; namely, that the biointrusion layer reduces water storage capacity, while the sand drainage layer increases water storage capacity. EFR concludes that these projected performance differences will have opposite and offsetting effects on projected percolation and that the cover design differences ". . . should results on only marginal differences in hydrologic performance."

IN ITS RESPONSE, EFR also states in its response that for the White Mesa cover system, it will maintain a rough surface on all but the uppermost lift to ensure that interlift zone is as non-transmissive as practical.

IN ITS RESPONSE, EFR also states that it proposes to construct test strips where the lift thickness and equipment are varied prior to construction [of the final cover system]. The purpose of these test strips is to identify lift thicknesses and equipment that promote uniform soil compaction without over-compacting the soil, rendering the soil suitable for establishing vegetation in the cover system.

14.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A; INT 14/1; Cover Test Section and Test Pad Monitoring Programs

The Division has a concern that comparing the performance of the proposed ET cover at the White Mesa Mill Site to the performance of the Monticello tailings repository cover system is inappropriate, for several reasons. For example, the cover system at Monticello is a composite system (having several types of highly-specialized layers designed to accomplish various physical objectives). More specifically, the cover system at Monticello differs significantly in design and operation from the currently selected monolithic cover system proposed for White Mesa in that (1) the Monticello cover system includes an animal intrusion barrier (consisting of cobbles at about 1 m (~ 3 feet) of depth), and (2) a capillary barrier (at ~ 1.6 to 2 m, located below the animal intrusion barrier, below another layer of soil, and just above the radon barrier). Each of these cover system components provide important functions not accomplished in the currently-proposed monolithic soil ET cover design for White Mesa.

In addition to differences in design between the Monticello repository cover and the proposed ET cover for the White Mesa Site, there are fundamental differences in the properties of the soils used to construct the Monticello cover compared to the soils currently proposed for use in constructing the ET cover at White Mesa. For instance, soils proposed by EFR for use in constructing the ET cover are extremely low in natural organic matter (OM) content, e.g., compared to soils that were used for constructing the Monticello Tailings Repository cover system e.g., zero to about 0.4 % according to Table D-5 in Appendix D of the Revised ICTM Report, compared to a recommended minimum OM content of from approximately 1.5 to 3.0%). These factors indicate that, given the natural climate conditions at the site (which could include possible prolonged (e.g., decadal to multi-decadal) future drought periods likely to create conditions unfavorable for sustaining

plant growth in the cover), and without substantial and extensive OM enhancements incorporated into the soils prior to cover construction and possible periodic active post-closure intervention/maintenance measures such as reseeding, possible irrigation of the cover, etc..., the on-site soils tested to date appear to be unfavorable for use in constructing the ET cover (see also discussion in Section 2.3.1 of the Technical Memorandum, White Mesa Mill Site – Revised ICTM Report Review addressing EFR's Response to Rd 1 Interrogatory 02/1 on the Revised Infiltration and Contaminant Transport Modeling Report).

The Division also notes the following statements made by EFR in in the Revised ICTM Report (Denison Mines 2010):

- **On Page 4-2 in the Revised ICTM Report (Denison 2010), EFR states "Furthermore, results from nearby uranium mill tailings lysimeter at Monticello (Waugh et al., 2008) also agree with model predictions for the proposed cover system at White Mesa." The Revised ICTM Report proceeds to compare modeled infiltration rates at the proposed cover at White Mesa with measured infiltration rates associated with the Monticello cover.**
- **On Page 4-2 in the Revised ICTM Report (Denison 2010), EFR also states " The model-predicted infiltration rates for monolithic ET cover are consistent with data reported from lysimeter and infiltration modeling studies of other vegetated ET covers (e.g., Albright et al. 2004; Bolen et al. 2001; Fayer and Gee 2006; Gee et al., 1994; Scanlon et al. 2005).**

After referring to studies by Bolen et al. (2001), Albright et al. (2004), and others mentioned, the Revised ICTM Report states, "In summary, a monolithic ET cover is the preferred design to minimize infiltration necessary to meet the Permit (Part I.D.8) and meet the radon attenuation standard." However, the cover systems described in several of these cited references contain different design components, such as a capillary break, that are not included in the currently proposed ET cover. For example, Bolen et al. 2001 review ET cover systems at 12 sites. Unlike the proposed White Mesa cover system, a number of the 12 cover systems reviewed by Bolen et al. (2001) are reported to contain either a sand layer or a gravel layer of appreciable thickness, which may act as a capillary barrier/ capillary break. Albright et al. 2004, who discuss the same 12 sites, state that six of them have a capillary barrier/break layer. Also unlike the proposed cover system at White Mesa, however, nearly all (i.e., 10 of 12) of these sites have geosynthetic root barriers consisting of nonwoven geotextile containing lumps of slow-release trifluralin (herbicide-like plant root inhibitor) (see also Albright et al., 2004). Each barrier is installed between interim cover and the overlying final cover system. Trifluralin acts to prevent plant biointrusion into waste by interfering with root mitosis so that its use at a site can modify impacts of rooting, biointrusion and drainage through a cover system.

The other studies mentioned by EFR also refer to sites with cover systems having substantial differences from the proposed White Mesa site cover system. Fayer and Gee (2006), for example, describe performance of four types ET cover systems at the Hanford Lysimeter Test Facility at a semi-arid site in Hanford, Washington for periods of up to 17

years. Of interest here is that each type of cover system described incorporates a capillary barrier/break layer, as part of the "Hanford Barrier", in some form.

The cover design for the Crescent Junction, Utah tailings repository (relocation repository facility for the Moab tailings) also contains a combination "Infiltration and Biointrusion" Barrier" underlying the frost protection component of the cover and overlying the radon barrier layer in the cover (see, e.g., DOE 2012, Addendum E, p. 14).

Several published studies demonstrate that incorporating a capillary barrier (with an adjacent granular filter layer) can substantially reduce cover infiltration rates. For example, a comparison of two otherwise similar cover systems (one monolithic with a thick soil cover, and one non-monolithic, with a capillary barrier) in terms of their ability to restrict drainage shows that the cover system with a thick soil cover was outperformed by the cover system having a capillary barrier by up to a ten-to-one ratio or greater (Porro 2001). Similar results were obtained in forced irrigation testing of alternative cover systems by Martian et al. 2001. Infiltration reduction depends on cover-system materials and environmental conditions. Hydraulic performance is evaluated as the probability that ET from the water-storage soil layer overlying the capillary break layer is sufficient to prevent water accumulation in the soil sponge layer from exceeding its storage capacity in any given year. The potential benefits in cover system infiltration performance with a capillary barrier are well documented.

For reasons described above, the Division also finds that the technical adequacy of a monolithic ET cover at the White Mesa site is not adequately supported by the comparisons EFR provides to other cover systems as described in technical references cited by EFR.

With respect to a Test Pad/Test Section, the Division believes that there is value in, and a need for, constructing and monitoring a pilot test pad or pilot test section *prior to* full-scale cover construction, and in a location off of the tailings. Information and benefits that can be gained from such pilot testing include:

- **Helps establish/verify a performance standard for the cover;**
- **Validates the cover design and construction;**
- **Could result in suggestions for improved design features and construction methods when implementing the full-scale cover construction; and**
- **Helps to identify and resolve problems that may be encountered during full-scale cover construction, e.g., allow engineers to evaluate, plan for, and/or mitigate factors such as vegetation establishment (in)effectiveness and address issues such as loss of one or more planted species following seeding/vegetation placement, desiccation cracking during or following cover layer placement and compaction; etc..., and**
- **Provides monitoring data (e.g., from field-scale pan lysimeters) to help evaluate the future infiltration performance of a full-scale cover constructed to a similar set of standards and using the same construction equipment and construction methods, as**

well as reduces risks associated with potential failure of, or disruption of in-situ cover conditions resulting from emplacement of, one or more monitoring devices installed within the full-scale cover system.

Advance construction and testing of such a Test Pad or Cover Test Section would allow engineers to obtain data on key characteristics of the constructed cover soils that are important for vegetation establishment such as soil nutrients, propagules, and microorganisms (e.g., mycorrhizae) needed to establish a sustainable plant community. Data collected on concentrations of soil macronutrients (e.g., nitrogen, phosphorus, and potassium) and micronutrients (e.g., sulfate, zinc, iron, manganese, copper, calcium, magnesium, sodium, and boron) in the constructed test cover could be used to assess whether they are similar to and within typical ranges for soils around the site which have been selected for use as a natural analog or analogs for predicting the final cover vegetation characteristics and performance.

The sustainability of the ET cover may rely, in part, on the establishment and resilience of a diverse plant community; however, the dynamics of such a plant community are complicated and effects are difficult to predict (e.g., Waugh et al. 2008). Link et al. 1994 indicate that, even in the absence of large-scale disturbances, seasonal and yearly variability in precipitation and temperature will cause changes in species abundance, diversity, biomass production, and soil water extraction rates on covers. Poor shrub establishment, for example, could result in poor water extraction, causing water accumulation in the lower portions of the cover profile during exceptionally wet precipitation periods (percolation exceeding the total storage capacity or drained upper limit of the soils). Data on soil structure development observed to occur over time within a constructed test cover profile following its construction could also be acquired and compared to that observed in natural soils at the selected analog site(s) to assess conditions that could be expected to develop in the future full-scale cover with respect to whether they may be suitable for promoting future development and sustainability of such shrubs, if desired based on the cover infiltration modeling results.

On the basis of the considerations discussed above, the Division requests the following:

- **EFR will need to provide a detailed Technical Work Plan for Division review and approval, no later than 90 days after approval of the revised Infiltration and Contaminant Transport Modeling (ICTM) Report by the Division, for constructing, monitoring and testing a Cover Test Pad//Test Section representative of the intended full-scale cover system. The Work Plan shall: (1) provide a construction schedule; (2) provide details of the proposed Test Pad/Section's design and construction; (3) describe the proposed monitoring/testing program duration; (4) define parameters to be monitored/tested in the Test Pad/Test Section; (5) provide a schedule and details regarding reporting of monitoring and testing results; (6) describe objectives of the Test Pad/Test Section construction, monitoring, and testing program; and (7) propose and justify criteria for demonstrating that those objectives have been achieved.**

- **The Test Pad/Test Section Work Plan will need to address acquisition of data for parameters (e.g., percolation data, weather data, fertilization and nutrient content data and other soil testing, botanical data,...) to validate assumptions and predictions made by EFR with regard to the projected site-specific and cover-specific performance of the full-scale cover, including future emergence rates and characteristics of vegetation on the cover.**
- **The Reclamation Plan should be revised to incorporate the information and requirements described herein with regard to this Test Pad/Test Section.**

EFR's proposal to maintain a rough surface on all but the uppermost lift in the cover is acceptable and EFR should incorporate this commitment into Attachment A of the next revision of the Reclamation Plan.

15.0 Financial Surety Arrangements

15.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-24-4; 10CFR40, Appendix A, Criterion 9; INT 15/1; Financial Surety Arrangements

The interrogatory requested that EFR do the following:

1. Justify the decrease in costs estimated for mill decommissioning and reclamation of Cells 1, 2, and 3 from those estimated in the White Mesa Reclamation Plan, Rev. 4.0 dated November 2009. Explain why several estimated levels of effort (e.g., total effort for Mill Yard Decontamination, Ore Storage Pad Decontamination, Equipment Storage Area Cleanup and Cell 1 Construct Channel) are smaller in 2011 than those estimated in 2009. Explain and rectify apparent discrepancies between labor rates used in cost estimates and those presented in the exhibit in Attachment C titled "Labor Costs".
2. Identify analytes for which soil samples identified in the cost estimate for "Cleanup of Windblown Contamination" will be analyzed. Justify (or revise with justification) the assumed sample analysis cost of $50.
3. Revise and report estimated reclamation costs, incorporating responses to instructions listed above.
4. Estimate and report the costs for a third party to conduct decommissioning and impoundment reclamation in the coming year rather than at the end of planned life.
5. Please provide and justify estimates of costs associated with complying with the current Air Quality Approval Order (DAQE-AN1205005-06, issue date July 20, 2006) and License Condition 11.4 and 11.5 during final reclamation, as stated in Section 1.5 of Reclamation Plan 5.0, Attachment A, Technical Plans and Specifications.
6. Please state and justify the times projected to be necessary to dewater Cell 2 and Cell 3. Provide and justify estimates of all costs associated with the apparently lengthy dewatering time for Cell 2 and Cell 3 (Also see Interrogatory 7/01, item 8).

15.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24-4; 10CFR40, APPENDIX A, CRITERION 9; INT 15/1; Financial Surety Arrangements

IN ITS RESPONSE, EFR committed to answering quantitatively all aspects addressed in the interrogatory only after the cover design is "conceptually approved". EFR also indicated that: (1)Costs for complying with the Air Quality Approval Order and current license condition, and costs for dewatering of Cells 2 and 3 are incidental to the daily operation at the White Mesa Mill and are covered in the Miscellaneous section of the Reclamation Cost Estimate; (2) The current cost estimate for dewatering of Cells 2 and 3 includes the construction and operation of a holding pond for solution from the dewatering of the tailings cells; and (3) O&M costs for the dewatering of Cells 2 and 3 will be re-evaluated once the final cover design is conceptual approved.

15.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-24-4; 10CFR40, Appendix A, Criterion 9; INT 15/1; Financial Surety Arrangements

EFR must submit and receive approval of its revised cost estimates before the Division will approve EFR's proposed and revised cover system design.

EFR has inadequately addressed the time required to dewater Cell 2 and Cell 3 prior to final cover construction, EFR should submit technically supported quantitative projections of the times required to achieve moisture contents for these cells upon which the final covers can be constructed with expectation that the dewatered tailings will not likely contribute to instabilities in the covers. These quantitative analyses should consider all mechanisms that affect water content of the tailings, including (but not limited to) precipitation, runoff, infiltration, lateral drainage, transpiration, evaporation, percolation, groundwater migration, and active removal. Quantitative analyses should also include uncertainty and sensitivity analyses to account for known and likely uncertainties in input parameter values and their effects on dewatering. The Reclamation Plan must include a detailed description of dewatering measures that EFR will use to accomplish dewatering of Cells 2 and 3 within the 7 year-time period specified in the latest Financial Surety submitted to the Division by EFR (See also Section 7.3 above). The current Surety submittal of March 14, 2012 (including the revised submittal dated September 14, 2012) does not list the time to dewater Cell 2. However, all other cells show a 62,400 hour dewatering time). Costs of the specific dewatering measures need to be included in the Financial Surety. Because this revised evaluation and the revised reclamation cost estimates described above were not submitted with EFR's response to the Rd 1 interrogatories, this issue will remain open.

16.0 Radiation Protection Manual

16.1 Round 1 Interrogatory White Mesa RecPlan REV 5.0 R313-15-501; 16/1; Radiation Protection Manual

The interrogatory requested that EFR do the following:

Refer to Appendix D, Radiation Protection Manual for Reclamation:

Provide information on how these largely operational radiation protection practices will change to support the changed needs of decommissioning and reclamation. Describe how the Radiation Protection program will be evaluated and revised to address the range of activities required to support decommissioning and reclamation activities. The following are selected examples of topics (not exhaustive) that should be evaluated and possibly revised to support decommissioning and reclamation.

- **Section 1.3 Beta Gamma Surveys:** Conduct beta gamma frisk surveys where appropriate during decommissioning and reclamation.
- **Section 1.4 Urinalysis Surveys:** State the frequency of conducting urinalyses during decommissioning and reclamation.
- **Sections 2.1.2, 2.3.2, 2.4.2 Frequency/locations:** State how the frequency and locations for all monitoring methods will be modified to accommodate decommissioning and reclamation activities.

16.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-15-501 INT 16/1; Radiation Protection Manual

IN ITS RESPONSE, EFR indicated the Radiation Protection Manual (RPM) for Reclamation has been updated (Revision DUSA-2 dated 05/12) to include practices for decommissioning and reclamation. The updated manual begins to address some of the changes that will be necessary once the mill transitions from operations to decommissioning and reclamation. However the document is still generally focused on operations and does not address how the program will be modified to address the unique decommissioning requirements, or the process through which the manual and program will be revised in the future.

Based on the RPM as provided in the response, during decommissioning the contamination control surveys that are required in Section 2.6.3 of the decommissioning plan will be limited to surveys for alpha contamination, similarly the "Radiation Survey of Equipment Released for Unrestricted Use", will be limited to surveying equipment for fixed and removable alpha contamination and beta gamma dose rates. The updated RPM gives the RSO the ability to remove areas from the routine survey list but does not indicate how areas established during decommissioning may be added if appropriate, to the routine survey list. The RPM does not include the procedures for gamma radiation surveys that are discussed in the response document.

16.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0; R313-15-501; INT 16/1; Radiation Protection Manual

The Division requests that EFR revise the RPM to specify how the program will be modified to address the unique decommissioning requirements, or the process through which the manual and program will be revised in the future. EFR should also include procedures for gamma radiation surveys in the revised RPM that are discussed in the response document. Because this revised information was not submitted with the response, this interrogatory will remain open.

17.0 Response to Int White Mesa Recplan Rev 5.0 R313-15-1002; INT 17/1; Release Surveys

17.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-15-1002; INT 17/1; Release Surveys

The interrogatory requested that EFR do the following:

Refer to Attachment D, Section 2.6, Release Surveys:

Revise to address the decontamination, release, and disposal of equipment and buildings necessary to support decommissioning and reclamation. Develop and present detailed release survey procedures and identify appropriate radiation survey equipment that will be used. Develop and present additional decontamination procedures during decommissioning and reclamation and include section on disposal of equipment that cannot be decontaminated.

17.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 Rev 5.0 R313-15-1002; INT 17/1; Release Surveys

IN ITS RESPONSE, EFR provided reasonable procedures for alpha and beta-gamma surveys. The selection of equipment is judged appropriate on the strength of the Division's previous reviews and acceptance of the Radiation Protection Manual for Reclamation. EFR has, however, inadequately addressed the Division's requests for additional information regarding decontamination, release, and disposal of equipment and buildings during decommissioning and Reclamation.

17.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0 R313-15-1002; INT 17/1; Release Surveys

EFR should yet either (1) cite previously submitted documents where these topics were addressed or (2) develop and submit for the Division's review and approval the following:

- **Decontamination procedures for buildings and equipment.**
- **Disposal of building components and equipment either on-site or off-site, depending on results of release surveys.**

18.0 Response to Int White Mesa Recplan Rev 5.0 R313-12; INT 18/1, Inspection and Quality Assurance

18.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 5.0 R313-12; INT 18/1; Inspection and Quality Assurance

The interrogatory requested that EFR do the following:

Refer to Attachment A, Plans and Technical Specifications, Section 1.6, Inspection and Quality Assurance: Revise the provided the "Radiation Protection Manual for Reclamation" cited in this section, to define the responsibilities and duties of the Radiation Safety Officer.

Refer to Attachment A, Plans and Technical Specifications, Section 1.8b, Inspection and Quality Assurance: Revise the wording to indicate that the DRC **must** review and approve all design modifications to the Reclamation Plan.

18.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-12; INT 18/1; Inspection and Quality Assurance

IN ITS RESPONSE, EFR indicated the following:

Section 1 of the Radiation Protection Manual for Reclamation (Attachment D of the Reclamation Plan, Revision 5.0) has been revised to include the responsibilities of the Radiation Safety Officer during reclamation (see Attachment E to the May 31, 2012 response document); and

The wording in section 1.8b of the Technical Specifications will be revised to indicate the DRC must review and approve all design modifications to the Reclamation Plan.

18.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0 5.0 R313-12; INT 18/1; Inspection and Quality Assurance

EFR has inadequately defined the responsibilities and duties of the Radiation Safety Officer in its revision of the Radiation Protection Manual for Reclamation.

EFR has committed to, but must yet revise Section 1.8b of the Technical Specifications to indicate that the Division must review and approve all reclamation plan design modifications.

19.0 Response to Int White Mesa Recplan Rev 5.0 R313-24; 10CFR4.42(J); INT 19/1, Regulatory Guidance

19.1 Round 1 Interrogatory White Mesa RecPlan Rev. 5.0 R313-24; 10CFR 40.42(J); INT 19/1; Regulatory Guidance

The interrogatory requested that EFR do the following:

Refer to Attachment A, Plans and Specifications, Sections 6.4 Guidance:

Please revise the decommissioning plan to reference and incorporate current guidance, namely NUREG-1757 "Consolidated Decommissioning Guidance"; NUREG-1575 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)"; and NUREG-1575 Supplement 1 "Multi-agency Radiation Survey and Assessment of Materials and Equipment Manual (MARSAME)".

19.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan 5.0 R313-24; 10CFR 40.42(J); INT 19/1; Regulatory Guidance

IN ITS RESPONSE, EFR committed to, but must yet revise the Reclamation Plan to reference and incorporate guidance provided in the following documents:

- *"Consolidated Decommissioning Guidance", NUREG-1757*
- *"Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)", NUREG-1575*
- *"Multi-Agency Radiation Survey and Assessment of Materials and Equipment (MARSAME)", NUREG-1575, Supplement 1*

19.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0 R313-24; 10CFR 40.42(J); INT 19/1; Regulatory Guidance

Beyond EFR's commitment to revise the Reclamation Plan to reference and incorporate guidance, EFR must yet actually revise the document and submit it for the Division's review and approval.

20.0 Response to INT WHITE MESA RECPLAN REV 5.0 R313-24; 10CFR40, Appendix A, Criterion 6(6); INT 20/1, Scoping, Characterization, and Final Surveys

20.1 Round 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24; 10CFR40 Appendix A Criterion 6(6); INT 0/1; Scoping, Characterization, and Final Surveys

The interrogatory requested that EFR do the following:

1. Refer to Attachment A, Plans and Specifications, Sections 6.6 Scoping Surveys & Figure A-1: Provide a figure identifying the areas and survey grid sizes. Clarify how use of the large grids and the spacing shown in Figure A-1 will ensure compliance with the 100 square meter criteria. Explain how samples will be collected from these larger grids.
2. Refer to Attachment A, Plans and Technical Specifications, Sections 6.6 Scoping Surveys: Provide details (including information on instrument sensitivity) on the beta gamma radiation instruments that will be used for the scoping surveys. Indicate the frequency of calibration checks, daily operational checks, and other QA/QC requirements for the instruments. Also indicate whether these same instruments (used during facility operations) will be used for subsequent characterization, remediation, and final survey work.
3. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.6 Scoping Surveys:* Explain how areas contaminated with radium, thorium, and uranium will be identified and surveyed to ensure they will not result in a dose that is greater than the radium standard alone.
4. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.6 Scoping Surveys:* Identify what types of samples (e.g., grab or composite samples) will be collected to support developing the gamma correlation. Explain how locations for taking these samples will be selected. State how many correlations will be developed and how they will differ from each other.
5. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.6 Scoping Surveys:* Identify the analytes including radioisotopes for which samples will be analyzed by chemical analysis and identify the preferred analytical method.
6. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.6 Scoping Surveys:* Provide information on how other materials that may be left will be identified during scoping surveys. Identify additional survey procedures for alpha beta and gamma surface surveys as appropriate.
7. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.7 Characterization and Remediation Control Surveys:* Explain how many and how samples will be collected to ensure the correlation developed for the scoping is consistent with the characterization and reclamation surveys. Explain how the correlation will be modified to address gamma variations that may arise during decommissioning and reclamation?

8. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.8 Final Survey, Figure A-2 and Attachment B Construction QA/QC Plan, Section 5.4.1:* Please clarify the terminology used in the two documents. Ensure that the activities described are consistent. Provide details on how the 10% of locations are selected for sampling. Demonstrate that collection of four samples as shown on Figure A-2 is sufficiently representative of the entire 100-square-meter area. Explain whether samples taken from the four sample locations identified in Figure A-2 will be analyzed separately or will be composited.
9. *Refer to Attachment A, Plans and Technical Specifications, Sections 6.8 Final Survey, Figure A-2:* Explain how the areas where final survey soil sample results exceed the criteria will be addressed. State the basis for determining whether additional removal will be required. A soil sample that exceeds the criteria may also indicate a problem with the gamma correlation. Since the majority of the area will be released based on the gamma correlation, explain how the gamma correlation will be reviewed to ensure the use of the correlation in place of sampling is still valid.

20.2 EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev 5.0 R313-24; 10CFR40 Appendix A Criterion 6(6); INT 20/1; Scoping, Characterization, and Final Surveys

IN ITS RESPONSE, EFR indicated the following:

"Using process knowledge and site history, Energy Fuels Resources (EFR) will identify areas of the site where the type of contamination is generally homogeneous (that is a comparable contaminant signature) and the geology is similar. At this time, EFR expects delineate two areas: tailings and an associated windblown area, and ore storage area and an associated windblown area.

Each area within the restricted area has been divided into sub-areas of size 30 meter by 30 meters for the scoping gamma radiation survey. Contamination is probable in these sub-areas and, following remediation, they would correspond to Class 1 or Class 2 MARSSIM areas. The gamma radiation survey plan shown in Figure A.1 has been revised and is attached as the Revised Figure A.1. The 30 meter by 30 meter area will cover each of the 10 m cells (blocks in the drawing) within each survey sub-area.

Effectively, a pattern of three transects per 30 meters provides coverage at the 10 meter by 10 meter area, and this is suitable for the scoping survey. If any measurement within the 30 meter by 30 meter area exceeds the action limit, a more detailed survey will be conducted within the 10 meter by 10 meter block(s) which exceeded the action limit.

Areas where wind-blown contamination may be present will be divided into similar subareas and the survey will continue outward from the restricted area until a buffer area of gamma radiation

radioactivity below the sum rule limit has been established. This will bound the area for remediation and final status surveys.

Alternatively, gamma radiation scanning using the GPS-integrated system will be conducted with a similar density as used in the Ludlum-19 methodology during the scoping surveys. As before, if any measurement exceeds the action limit, a more detailed survey will be conducted locally.

The scanning gamma radiation levels from the scoping survey will be used to assist in selecting locations for sample collection to develop the initial scoping level prediction correlation. Locations where the sum rule is expected to be 0.5, 1 and 2 (corresponding to incremental Ra-226 concentrations of 2.5, 5 and 10 pCi/g) will be selected, based on historic knowledge and field observations, to accurately reflect the relationship near the decision point. In addition, locations with higher concentrations, or areas where substantial disequilibrium is anticipated, will be sampled.

Gamma radiation surveys will be conducted either with the existing Ludlum-19 methodology that has been used for previous remediation at White Mesa or with a GPS integrated system using 2 inch by 2 inch sodium iodide (NaI) detectors, or the equivalent.

As indicated in the Mill's Radiation Protection Reclamation Manual, each existing instrument (Ludlum 19) used will be calibrated by an off-site 3rd party, every 6 months.

Daily function checks will be conducted and documented each morning before use. This information will be housed in the Radiation Department. A function check is also performed once the instruments return from calibration. This function check is documented, and the daily checks are compared against this initial function check. If the daily checks are off by more than ±10%, the instrument is considered no longer reliable and must be sent in for calibration. All function checks are performed using a Cs-137 check source, similar to the 3rd party calibration laboratory.

The gamma radiation detectors to be used for the integrated-GPS methodology would be 2 inch by 2 inch sodium iodide detectors (e.g. Ludlum 44-10 or equivalent) with a ratemeter (e.g. Ludlum 2221 or equivalent) equipped with RS-232 export. The data is exported to a GPS data logger for availability for mapping and survey interpretation.

These detectors are sensitive to environmental gamma radiation levels and typically provide suitable precision for gamma radiation correlations below a level of 5 pCi/g.

Similar procedures to those currently used with the EFR Ludlum-19 methodology would be developed, including for example, calibration and daily checks, if the GPS-integrated methodology approach is selected,

A gamma radiation level that provides confidence that the sum rule is less than unity for the survey unit will be established. This will be derived from the correlation between gamma radiation and the sum rule from measurement data collected during the scoping survey. The gamma radiation survey data will be analyzed to determine the extent of contamination requiring remediation in each area based on this correlation.

Soil samples collected during the scoping survey will be grab samples from locations determined based on institutional knowledge and site history to ensure spatial coverage, homogeneous areas relative to contamination type and geology and the range of gamma radiation levels recorded in the scoping gamma radiation survey. At each sampling location, a static gamma radiation measurement over a one minute duration will be recorded with the same instrumentation and height above the soil as used in the scanning surveys. Based on experience, the incremental gamma radiation corresponding to 5.0 pCi/g Ra-226 is approximately 5,800 cpm for an un-collimated 2 inch NaI detector. Selection of sample locations will ensure that locations corresponding to incremental concentrations of 2.5, 5 and 10 pCi/g are selected to optimize the prediction uncertainty at the 5 pCi/g Ra-226 incremental concentration.

Correlations between the sum rule and gamma radiation will be developed with potentially different relationships depending on the area. It is expected that the relationships will generally not be dependent on the mixture of radionuclides in each area. Most of the incremental gamma radiation is likely to be associated with Ra-226. Unatand Th-230 are weak gamma radiation emitters compared to Ra-226; however, expectations are that these concentrations are equal to or less than the Ra-226 concentrations. For example, ore will have these radionuclides generally in equilibrium and tailings will be depleted in uranium relative to Ra-226. However, there may be small areas with elevated Th-230 due to specific process wastes (e.g. raffinate crystals).

Differences in the relationship may be more dependent on variations in background due potentially to different geology. The correlations will be evaluated for the differences that depend on the area and the amount of precision (scatter of actual sum rule versus predicted sum rule). The target (two sigma) absolute uncertainty for mean predictions of the sum rule will be 0.2 at the decision point where the sum rule equals one; that is, the 95% confidence intervals when the mean prediction equals "1" will be 0.80 to 1.2 for the sum rule.

Soil samples will be analyzed using methods with minimum detection limit (MDL) that is no greater than 10% of the concentration limit developed from the radium benchmark approach. The current methods used by the laboratories utilized by EFR are shown in Table 1 and all meet the MDL objective noted above. The analytes and methodology are given in the following Table 1.

Table 1 Analytical Methods and Method Detection Limits

Radionuclide	***Method***	***RBD Benchmark***	***MDL***
Ra-226	*E903.0*	*5 pCi/g*	*0.2 pCi/g*
U-nat	*SW6020 Standard RL*	*545 pCi/g*	*0.01 pCi/g*
Th-230	*E908.0*	*46 pCi/g*	*0.2 pCi/g*

With respect to remediation of non-radiological hazardous constituents, NRC guidance in NUREG-1620, Section 5.2.2 states:

"The decommissioning plan must address the non-radiological hazardous constituents of the byproduct material according to 10 CFR 40 Appendix A Criterion 6(7). For windblown tailings areas, meeting the surface Ra-226 standard should be adequate to control these constituents in soil. A tailings cell cover that meets Appendix A criteria should control, minimize, or eliminate post closure escape of non-radiological constituents into surface water and the atmosphere. However any unusual or extenuating circumstances related to such constituents should be discussed in the reclamation plan or decommissioning plan in relation to protection of public health and the environment and should be evaluated by the staff."

EFR has reviewed the history of Mill operations and has identified the following two incidents which may be considered to have generated "unusual or extenuating circumstances" with respect to reclamation.

Ammonium Sulfate Tank Area

In response to a Stipulated Consent Agreement between EFR and the Director of the Utah Division of Radiation Control ("DRC"), EFR performed Phase I of a Nitrate Contamination Investigation described in a May 6, 2011 Investigation Plan approved by DRC. The Phase I investigation identified soil contamination near the Mill's ammonium sulfate storage tanks, specifically ammonia as N, and nitrate plus nitrate as N, which DRC attributed to spillage from storage and handling of ammonium sulfate process reagent. Because the attributed source of the contamination is not associated with ores or other sources of radiological contamination, EFR considers this area to represent an unusual circumstance in which non-radiological contamination may not be captured by excavation to the Ra-226 standard. EFR plans to remediate this contamination consistent with agreements existing or currently under review by DRC, as described below.

EFR entered a revised Stipulated Consent Agreement ("revised SCA") with DRC on September 30, 2011. Pursuant to the revised SCA, EFR submitted a revised Corrective Action Plan ("CAP") which, among other commitments, required that EFR:

- *determine the physical extent of the soil contamination observed at the ammonium sulfate, including an estimate of the volume of the contaminated soils down to but not including bedrock, and an estimate of the surface area at or above the estimated location of the contaminated soil volume;*

- *cover the Contaminated Surface Area with at least six inches of concrete, to the extent not already covered by concrete or existing buildings, and remove the Contaminated Soil Volume and dispose of the contaminated soils in the Mill's tailings impoundments prior to site closeout.*

The following process will be used to estimate the volume of contaminated soil to be removed during reclamation. Once the total area to be covered by concrete has been determined based on the borehole analyses, the area will be multiplied by the average depth to bedrock, as determined from the logging of the boreholes.

Based on the geologic logging performed during the soil probe sampling in the Phase I Investigation in June, 2011, borings number GP-25B and GP-26B in the vicinity of the ammonium sulfate tanks indicated depth to bedrock of 19 feet and 16 feet, respectively.

These values will be included, along with depths determined during the additional Geoprobe sampling to develop an average depth to bedrock. This average depth to bedrock will be multiplied by the area of contamination.

The revised CAP and resulting Consent Order is currently undergoing public review and comment. Following public comment and finalization of the CAP and Consent Order, EFR will characterize the areal extent of contamination consistent with the schedule in the revised CAP, and, at the time of Mill reclamation, excavate the contaminated soils associated with the ammonium sulfate storage area consistent with the requirements of the CAP and Consent Order.

Claricone Failure and Removal Action

The Mill experienced a spill from the failure of a partially below-grade clarifier (the "Claricone") on April 12, 2012. The spilled contents of the Claricone were expected to consist of an estimated 28,000 gallons of in-process solutions containing approximately 190 lbs of natural uranium and approximately 3,370 lbs of sulfuric acid.

During April 2012 contaminated soil was removed and disposed in Cell 3 as follows:

a. *All soils visibly wet, stained or discolored were excavated until uncontaminated dry background soils remained.*

b. *The bottom and sides of the excavation were scanned by microR meter. When the bottom or sides of the excavation indicated gamma levels greater than background levels, the excavation was resumed, additional contaminated soil was removed, and the bottom and sides of the excavation were re-scanned until all surfaces resulted in gamma levels less than or equal to cleanup background. (Cleanup background was defined as two times the average of four measured background readings. This approach accounted for the contribution to background of gamma radiation from other nearby process equipment such as the clarifier, thickener, and CCD impounds.) When the bottom and sides of the excavation indicated gamma levels of less than cleanup background as defined above, the excavation was considered complete, and the area was prepared for backfill and re-grading.*

EFR considered that the excavation, as conducted based on residual gamma screening was sufficient to ensure that all radiological and non-radiological constituents associated with the spill had been addressed. However, DRC advised EFR in a letter dated August 8, 2012 that because confirmation sampling was not conducted subsequent to soil removal, DRC required that EFR provide additional measures to ensure all contamination has been removed. EFR has proposed to provide a conservative overestimate of contaminated soils to be excavated at the time of reclamation. EFR will provide a report to DRC describing and justifying the estimated excavation volume.

Following approval of the report, and at the time of reclamation, EFR will excavate soil in the former Claricone area consistent with the approved Excavation Proposal.

The correlations are anticipated to remain the same during the program provided that the vertical gradient of incremental Ra-226 remains similar and that there are not variations in background encountered. Soils after excavation may have higher or lower concentrations than the established background due to differences in soil type. Soil samples will be collected during the verification and these will ensure the relationship is appropriate. These samples may initiate further excavation if the correlation is revised.

Locations for final verification will be established based on a combined selection of sampling points using process history and a random sampling approach for each investigation area. Following a final status gamma radiation survey, a minimum of 15 blocks in the survey area will be measured to confirm the gamma radiation guideline level. For these 15 samples, the five 10 meter by 10 meter blocks with the highest average gamma radiation will be sampled along with another 10 sample blocks randomly selected from the area. This will allow inspection of the highest gamma radiation blocks (which are more likely to have higher radionuclide concentrations) while verifying the relationship and provide a measured soil sample average for the area.

Multiple sampling locations within a 10 meter by 10 meter block provides a more precise measurement of the average sum rule for the block than would a single sample location.

The advantage of a composite sample is that the sample will more closely represent the average over the block yet only one sample requires measurement. The advantage of measurement of each sampling location (e.g. the four in Figure A.2 of Attachment A) is that the laboratory uncertainty is averaged out amongst the samples. For example, if the true concentrations were the same at each sampling point, the average of four locations will average out the laboratory uncertainty more than the measurement of a single composite. Based on achieving the desired MDLs for each radionuclide, a composite sample from each 10 meter by 10 meter area is considered acceptable.

Four locations per 10 meter by 10 meter block has been selected as appropriate for the site as contamination is generally expected to have smooth spatial variability (is not "spotty") particularly following remediation. Further, the soil sampling is largely confirmatory of the more extensive gamma radiation measurements and correlation.

Although not required by MARSSIM for the survey unit, further remediation on a sampled block will be conducted if the unity rule determined with the soil sample exceeds "1" for the soil layer. The remediation will follow the general approach used but would involve a more extensive gamma radiation survey to define the area and to ensure that the remediation is complete. A verification soil sample will be collected to confirm that the sampled block meets the sum rule. The revised, if necessary, correlation relationship will be implemented to determine if there are any 10 meter by 10 meter blocks with a sum rule prediction that exceeds "1". Any blocks exceeding the sum rule will be remediated, for example by removing an additional lift and resurveying."

20.3 Division's Assessment of EFR Responses to Rd 1 Interrogatory White Mesa RecPlan Rev. 5.0 R313-24; 10CFR40 Appendix A Criterion 6(6); INT 20/1; Scoping, Characterization, and Final Surveys

EFR reasonably addresses the nine topics contained in Items 1 through 9 of the interrogatory. The response provides procedures for how gamma surveys may be conducted and indicate instruments that may be used. These procedures and instruments are not included in the RPM. Additionally, a discrepancy exists between the RPM and the response document regarding the frequency of instrument calibrations. Section 3.1.4.2 of the RPM state "All beta-gamma survey instruments are sent out annually for calibration" whereas the response states "As indicated in the Mill's Radiation Protection Reclamation Manual each existing instrument (Ludlum 19) used will be calibrated by an offsite –third party every 6 months.

The Division requests that EFR incorporate the substance of these responses into the further revised Technical Specifications or other documentation pertinent to the Reclamation Plan. EFR must also resolve the discrepancy stated above. Because this revised information was not submitted with the response, this interrogatory will remain open.

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